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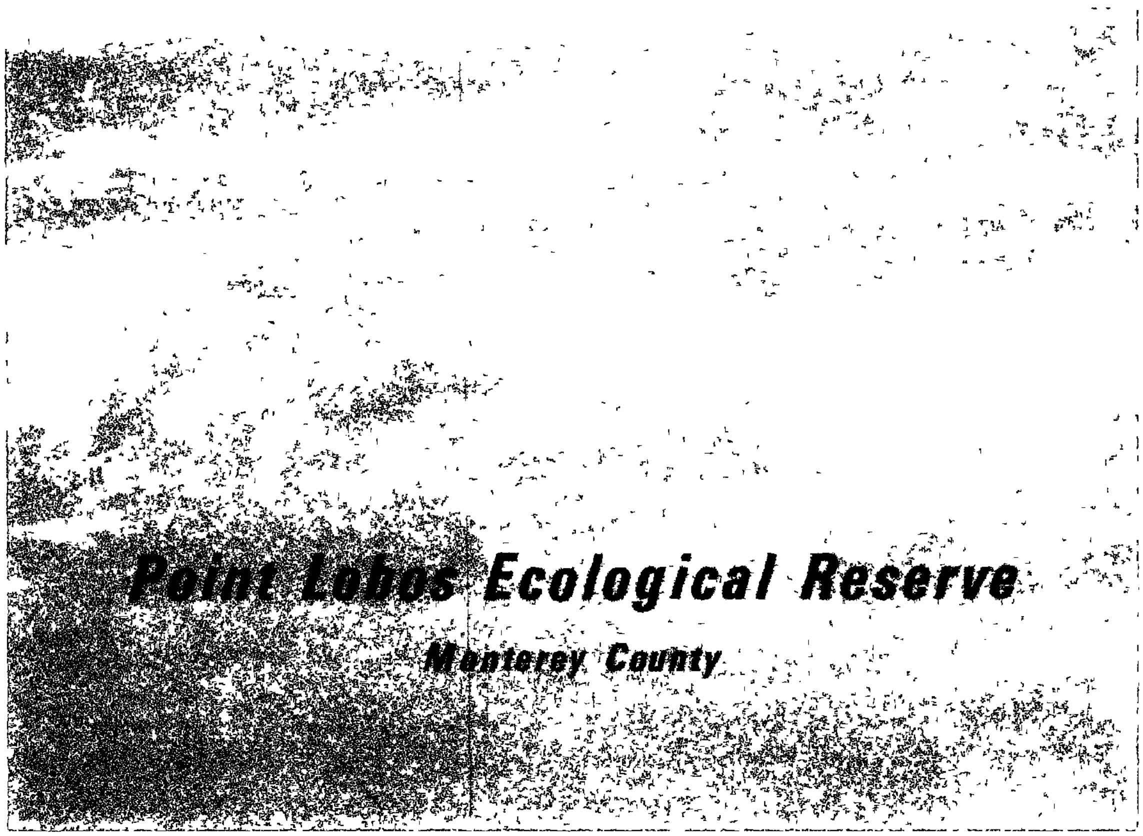
California Marine Waters
Areas of Special Biological Significance
Reconnaissance Survey Report



LIFORNIA STATE WATER RESOURCES CONTROL BOARD
DIVISION OF PLANNING AND RESEARCH
SURVEILLANCE AND MONITORING SECTION
April 1979

WATER QUALITY MONITORING REPORT NO. 79-9

Cover Photograph:

Point Lobos Ecological Reserve

Area of Special Biological Significance

Point Lobos Ecological Reserve Area of Special Biological Significance

STATE WATER RESOURCES CONTROL BOARD
AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE

Designated March 21, 1974, April 18, 1974, and June 19, 1975

1. Pygmy Forest Ecological Staircase
2. Del Mar Landing Ecological Reserve
3. Gerstle Cove
4. Bodega Marine Life Refuge
5. Kelp Beds at Saunders Reef
6. Kelp Beds at Trinidad Head
7. Kings Range National Conservation Area
8. Redwoods National Park
9. James V. Fitzgerald Marine Reserve
10. Farallon Island
11. Duxbury Reef Reserve and Extension
12. Point Reyes Headland Reserve and Extension
13. Double Point
14. Bird Rock
15. Ano Nuevo Point and Island
16. Point Lobos Ecological Reserve
17. San Miguel, Santa Rosa, and Santa Cruz Islands
18. Julia Pfeiffer Burns Underwater Park
19. Pacific Grove Marine Gardens Fish Refuge and Hopkins Marine Life Refuge
20. Ocean Area Surrounding the Mouth of Salmon Creek
21. San Nicolas Island and Begg Rock
22. Santa Barbara Island, Santa Barbara County and Anacapa Island
23. San Clemente Island
24. Mugu Lagoon to Latigo Point
25. Santa Catalina Island – Subarea One, Isthmus Cove to Catalina Head
26. Santa Catalina Island – Subarea Two, North End of Little Harbor to Ben Weston Point
27. Santa Catalina Island – Subarea Three, Farnsworth Bank Ecological Reserve
28. Santa Catalina Island – Subarea Four, Binnacle Rock to Jewfish Point
29. San Diego–La Jolla Ecological Reserve
30. Heisler Park Ecological Reserve
31. San Diego Marine Life Refuge
32. Newport Beach Marine Life Refuge
33. Irvine Coast Marine Life Refuge
34. Carmel Bay

CALIFORNIA MARINE WATERS
AREA OF SPECIAL BIOLOGICAL SIGNIFICANCE

RECONNAISSANCE SURVEY REPORT

POINT LOBOS ECOLOGICAL RESERVE

STATE WATER RESOURCES CONTROL BOARD
DIVISION OF PLANNING AND RESEARCH
SURVEILLANCE AND MONITORING SECTION

APRIL, 1979

WATER QUALITY MONITORING REPORT NO. 79-9

ACKNOWLEDGEMENTS

This State Water Resources Control Board Report is based on a reconnaissance survey report submitted by Gaye Violet Cazanian, Deborah J. Vanderwilt, Ann C. Hurley, Michael S. Foster, and James L. Cox of Moss Landing Marine Laboratories, Moss Landing, California. Also, the following Moss Landing Laboratory personnel assisted in the conduct of this project: Paul Larson, Martin Brown, Robert Cowen, Patrick Turney, Dan Reed, Bob Walkup, Howard Teas, Gary Ichikawa, Dennis Rox, and Rosie Keegan.

ABSTRACT

Point Lobos Ecological Reserve Area of Special Biological Significance is located in northern Monterey County along the central coast of California. The area lies approximately at the coordinates 36° 31' N latitude and 121° 56' W longitude and includes 5.5 miles (9.3 km) of shoreline, excluding islets.

Average yearly rainfall in the Area may vary appreciably. In general, precipitation is heaviest from November to April, with minor amounts from May to October.

Landside vegetation consists of a variety of floral community types, including pine forest, meadowland, sandhills and sea bluffs. Point Lobos has one of the two naturally occurring groves of Monterey cypress and about 600 species of native wildflowers.

Cyclic changes in turbidity levels, nutrient concentrations, water temperature and salinity in the nearshore waters are caused by three distinct oceanographic seasons. These are the oceanic season (August-November), the Davidson season (November-March), and the upwelling period (April-July).

The intertidal zone of the ASBS can generally be classified as open rocky coast. A diversity of habitats exist including pocket beaches, exposed or protected rocky areas, tidepools, and sheer cliffs. The biota includes gastropods, limpets, isopods, sand crabs, mussels, barnacles, polychaetes, amphipods, abalone, sea urchins, crabs and many other organisms. A variety of marine mammals are present within the ASBS at various times of the year, including Stellar and California sea lions, harbor seals and sea ottors.

The subtidal zone includes sandy, pebbly and kelp forest assemblages. The sandy habitat forms wide bands in the shallow subtidal zone varying

in texture from fine to coarse. This habitat supports burrowing and tube dwelling organisms such as worms, polychaetes, clams and sea cucumbers. The pebbly habitat occurs in areas of reduced tidal surge. Biota include polychaetes, turban snails, sea stars, abalone and burrowing anemones. The dominant alga in the kelp forest habitat is the giant kelp, with bull kelp less common. Fish within the ASBS are generally restricted to the kelp forest. They include greenlings, sculpins, rockfishes and several other species.

Unique components of the ASBS include the huge numbers and diversity of sealife, filter feeding invertebrates and the occurrence of giant kelp to unusual depths. Both occurrences are probably related to the extremely good water quality.

No municipal, industrial, agricultural or logging activities occur directly adjacent to the ASBS. Nature study, including diving for scientific, educational and photographic purposes is the principal recreational use of the area. Sport diving is not allowed.

Potential pollution sources include oil deposits from an unknown source, and agricultural and storm water runoff from the Carmel River. Pollution sources in the future may include increased sedimentation from proposed developments, radioactive emissions from a proposed nuclear power plant at Moss Landing and proposed sewage treatment facilities in the area.

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FINDINGS AND CONCLUSIONS

The Point Lobos Ecological Reserve ASBS contains a variety of marine habitats with an extremely diverse biota, including an abundance of filter-feeding organisms, kelp beds extending to unusual depths and unique occurrences of organisms. These features are probably due to the excellent water quality of the Area. Existing threats to this water quality include oil appearing on beaches and sediments entering the ASBS from the Carmel River. Possible future water quality threats include discharge of radioactive substances from a proposed nuclear plant at Moss Landing, sewage discharges from a proposed modification of the Carmel sewage outfall, and sedimentation from proposed developments nearby.

Water clarity is identified as a special water quality requirement for protection of the unique features of the Point Lobos ASBS.

INTRODUCTION

The Point Lobos Ecological Reserve ASBS, often called "the greatest meeting of land and sea", is an area of rugged beauty, monumental geologic structures and extremely diverse marine life. Protection of the valuable resources of Point Lobos began in 1935 when the area was opened to the public as a State reserve. In 1960, Point Lobos became the first underwater park in the United States and was designated a Registered National Monument in 1968. In 1973, Point Lobos acquired ecological reserve status, whereby all flora and fauna were protected and all waste discharges prohibited to maintain a natural environment. Point Lobos was designated as an Area of Special Biological Significance to further ensure the protection of this unique area.

Point Lobos Ecological Reserve has been maintained in pristine condition and therefore is extremely valuable for aesthetic and educational reasons. Numerous artists and photographers attempt to capture the beauty of Point Lobos. Thousands of people, including many school groups, come to Point Lobos each year to learn about its natural history and to study the geologic record present in the rock formations. Because of its varied habitats and natural conditions, Point Lobos ASBS is an excellent area for marine ecological studies, especially as it is an underwater park and is open to divers.

The purpose of this reconnaissance survey report is to provide a general description of the topography and biota of the ASBS, and of the physical and chemical factors, including possible water pollution, affecting it. This has been done by bringing together all existing literature on Point Lobos and augmenting this with qualitative surveys. It is extremely important to note that this report is <u>not</u> an environmental impact report and should not be used as such. Extensive quantitative surveys are needed to provide the information necessary for an environmental impact report. It is the intention of this report to summarize what is known and to provide information.

ORGANIZATION OF SURVEY

A survey of the existing literature provided an adequate description of the physical and chemical characteristics of the ASBS and the adjacent land vegetation. For land and water use descriptions and actual or potential pollution threats, the literature was supplemented by interviews with Paul Larson, park ranger at Point Lobos, and by attending the first workshop of the Point Lobos State Reserve Planning Team.

Because many organisms show seasonal variations in abundance, the described biota may not represent a comprehensive list of all common intertidal species within the ASBS. Descriptions of intertidal biota are based on visits to the ASBS during "minus" tides during November, December, March and April. Different areas and habitats within each area are qualitatively described in the context of community structure, noting composition and abundance of major organisms present. The pocket beach habitat is represented by Gibson Beach, Hidden Beach, Pebbly Beach, China Cove and Whaler's Cove. Exposed or protected rocky areas and tidepools were examined on the south shore of the Reserve from Headland Cove to White Cap.

Descriptions of subtidal biota at Whaler's Cove, Coal Chute Cove, Bluefish Cove, Cypress Cove, Headland Cove, Sandhill Cove, Hidden Beach, Novice Cove, China Cove, Gibson Beach and Pelican Point and the eastern side of Bird Island were obtained from published subtidal surveys in the existing literature. Descriptions of the remaining subtidal sampling sites are based on twenty-six dives made on May 19, 1978 (Appendix 1). Abundance of algae, invertebrates and fish were qualitatively estimated during transects extending from 80-45 feet deep to approximately 15 feet deep.

PHYSICAL AND CHEMICAL DESCRIPTION

Location and Size

Point Lobos Ecological Reserve ASBS is located in northern Monterey County along the central coast of California at 36°31'N latitude and 121°56'W longitude (Figure 1). The nearest town, Carmel, is 4 miles (6.4 km) north of the ASBS. The ASBS includes 775 acres (314ha) of surface water, approximately 25 acres (10ha) of intertidal area and 5.5 miles (9.3 km) of shoreline, excluding islets (Figure 2). The seaward boundary of the ASBS coincides with that of the Point Lobos Ecological Reserve. The landward boundary follows the mean high tide line of the Pacific Ocean between the southerly and northwesterly boundaries of Point Lobos Ecological Reserve.

Nearshore Waters

Currents: Three distinct oceanographic seasons characterize Point Lobos nearshore waters: the oceanic season (August-November), the Davidson season (November-March) and the upwelling period (March-July). Coastal waters are influenced by two large-scale currents whose nearshore presence varies throughout the year.

During the oceanic season, the California Current flows close to the shore. This wide, sluggish [moving less than 10 in/sec (25 cm/sec)] current forms the eastern leg of the large, permanent, clockwise-moving Pacific Ocean Gyre. Flowing south, it bathes the coast in cold nutrient rich subarctic water. The California Counter-Current or Davidson Current carries clear equatorial water northward and ordinarily flows 650 ft. (200 m) below the California Current. It occasionally surfaces near Point Lobos during summer months, moving approximately 20 in/sec (50 cm/sec). Wave action and surge are mildest during this period.

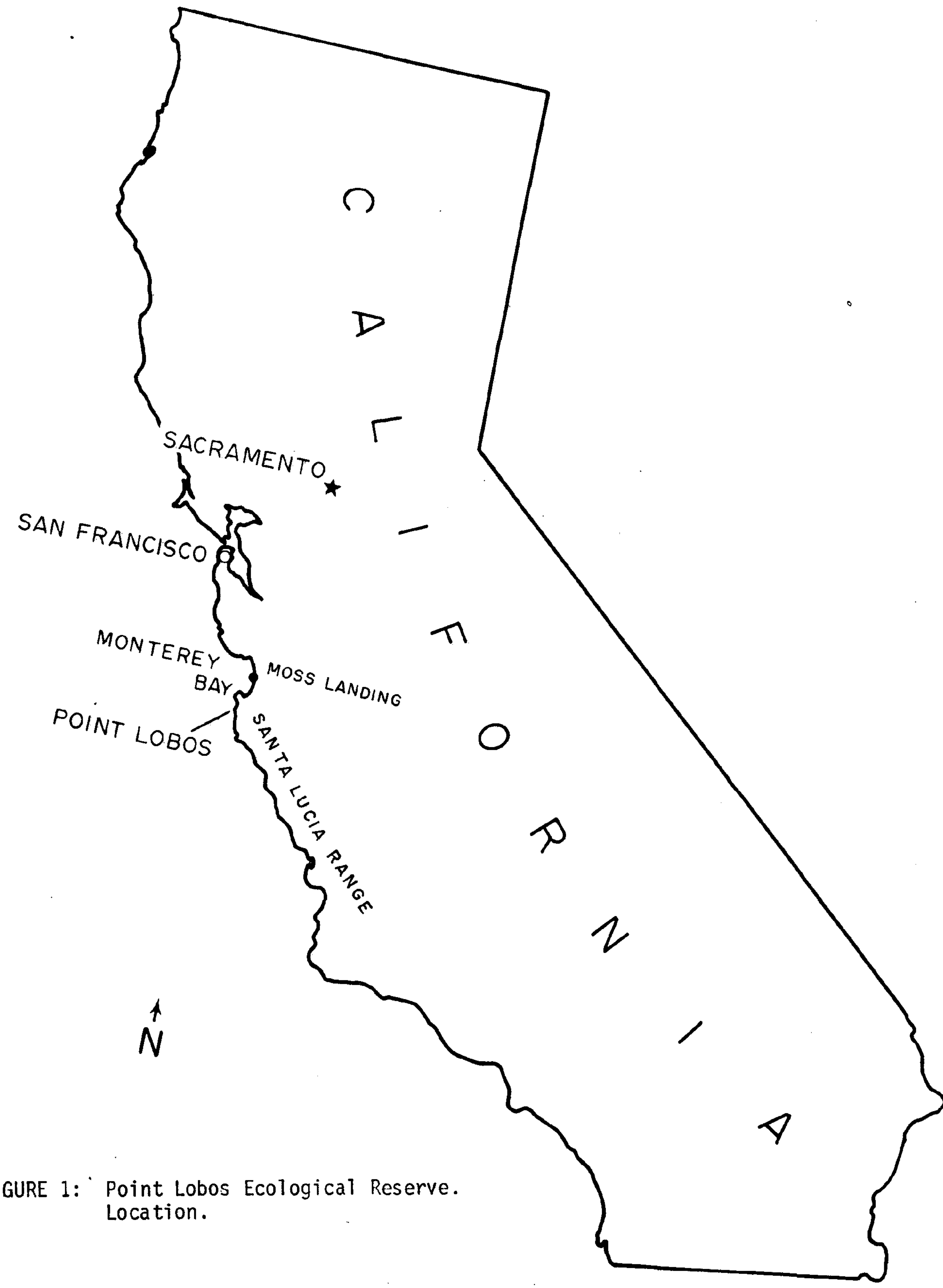


FIGURE 1: Point Lobos Ecological Reserve. Location.

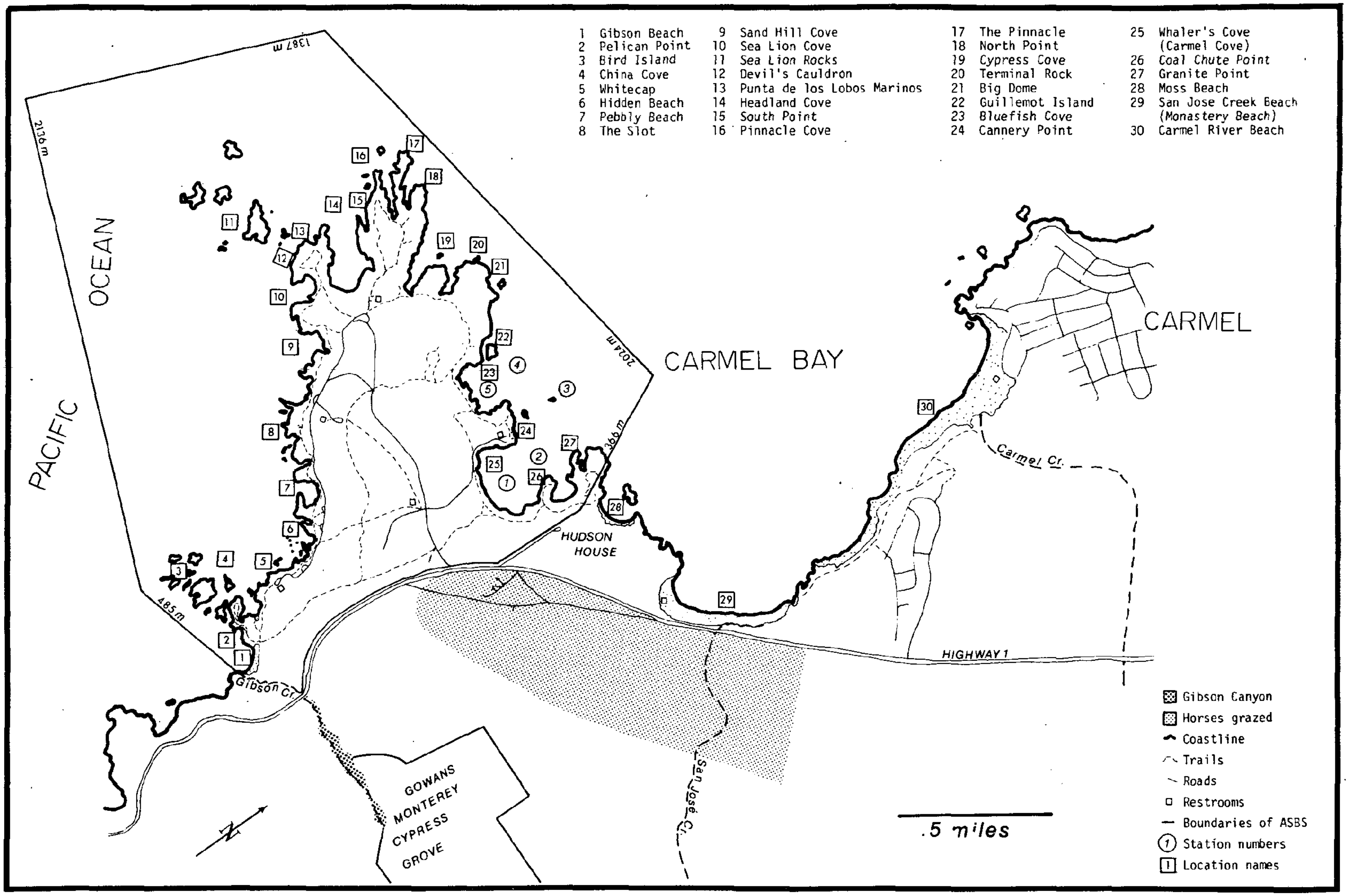


FIGURE 2: Point Lobos Ecological Reserve. Land Use and Description of Coastline. Source: Department of Parks and Recreation

In the winter, the Davidson Current surfaces between the land and the California Current. Strong south and southwest winds increase the surface speed of this current, and, with the Coriolis effect, act to drive nearshore waters against the shoreline. The Davidson period is therefore characterized by turbid, well-mixed waters, heavy surge and considerable wave action. When the strong south winds subside, the Davidson Current becomes submerged.

During the upwelling period, the California Current flows southward along the coast. Strong north and northwesterly winds and the Coriolis effect act to drive the surface waters of the California Current offshore. Subsurface waters from the Carmel Canyon move inshore and, as they reach the coastline, rise at a rate of 2.3-8.9 ft/day (0.7-2.7 m/day). This period is also characterized by strong wave action.

The time and duration of these oceanographic seasons often vary considerably with prevailing winds. Northwest winds may cause upwelling to occur in the midst of the Davidson period or at other times. Upwelling was detected during the oceanic period in October 1977. The above oceanographic events create seasonal changes in turbidity levels, nutrient concentrations, temperature and salinity of nearshore waters.

Water Quality: Turbidity changes are important to the biota of the ASBS. Turbidity may be caused by sediment, detritus or microscopic algae, fungi, protozoa and bacteria. Sediment and detritus are the more important causes of turbidity on the south shore of Point Lobos, while on the north shore, miscroscopic organisms are more important (Barry, 1977). Occasional "red tides", dense blooms of dinoflagellates, can greatly increase turbidity in the entire ASBS. Although no repeating turbidity cycles have been observed, turbidity is often lowest during calm autumn and early winter months and may increase considerably in the summer when macroalgal decay increases. Average turbidity ranges from 1.00-1.80 JTU (Jackson Turbidity Units) on the surface and from 0.45-3.70 JTU on the bottom at Whaler's Cove (Nichols, 1974). Divers have reported a range of visibility from 3-80 ft. (1-25 m) at different times of the year.

Salinity levels show little spatial or vertical variation and range from 25-31 ppt at Whaler's Cove. During upwelling, salinity levels are high, while the California Current waters characteristic of the oceanic period tend to have low salinity. Salinity levels during the Davidson period are particularly low due to fresh-water runoff from winter storms.

Point Lobos surface water temperatures are among the coldest in the State during the upwelling period. Minimum temperatures of 46.4°F (8°C) were recorded on February 3, 1971 and February 23, 1974 (Barry, et al, 1977). Surface temperatures are warmest during the oceanic season. A maximum temperature of 61.9°F (16.6°C) was reported on October 12, 1972 (Barry, et al, 1977). Yearly average surface water temperatures on the south shore are usually 1.8°F (1°C) colder than those on the north shore due to better mixing.

Higher air temperatures during the oceanic season heat the surface waters and a thermocline forms at the interface of the warm and cold water layers. The temperature difference between the two layers ranges from 0.9°F (0.5°C) in May to 5.4°F (3°C) in September. The presence of the thermocline varies with local conditions. Well-developed thermoclines are more common in the protected areas of the north shore where mixing is reduced, but are less pronounced when Marcocystis density decreases and are disrupted when storms create surface waves and heavy surge.

Nutrient levels are somewhat indicative of the oceanographic season. During upwelling, organic detritus which has settled out of the euphotic zone is brought to the surface, making these waters extremely rich in nitrates, phosphates and silicates. The combination of increased nutrient levels and solar radiation in the euphotic zone results in huge blooms of phytoplankton which, in turn, provide food for other organisms.

Heavy wave action during the Davidson period tears out large amounts of benthic algae and deposits them on the shore, where they are decomposed by bacteria. This decomposition often turns the littoral water a milky color. Decomposition and terrestrial runoff provide nutrients to the littoral and sublittoral zones. Offshore, however, nutrients are relatively scarce, and organisms begin to display complex feeding strategies. For example, when phytoplankton blooms are scarce algal symbionts often occur in various fauna.

Average dissolved oxygen and carbon dioxide vary less than 10% throughout the year in the ASBS. Dissolved oxygen averages 6.0 ppm near the bottom and 9.0 ppm on the surface in Whaler's Cove (Nichols, et al, 1974). Surface values range from 8-11 ppm over the year and generally show a decrease from April through November. Wave action in the winter increases the dissolved oxygen in surface waters. Carbon dioxide ranges from 6-8 ppm throughout the year. Occasional pockets of high carbon dioxide have been found within sheltered areas such as Whaler's Cove (Nichols, et al, 1974), but further investigation is needed to explain their presence.

In Carmel Bay, the pH of the water is approximately 7.9 and shows little variability throughout the area and year. Oil and grease range from 0.1-4.5 mg/liter. Ammonia, indicating the presence of sewage, is low (ESI, 1977).

Coliform levels on the north shore reached a maximum of 542 mpn/100 ml (most probable number) in 1969 (Nichols, et al, 1974). After this time, additional chlorine was added to the Carmel Sanitary District outfall and coliform values became more predictable (Figure 3). Monterey County Health Department monitors coliform on Carmel Beach twice weekly. Levels usually fall below the 1,000 mpn/100 ml set by the California Department of Health as the upper safe limit for coliform bacteria, but occasionally are higher (ESI, 1977). The reasons for these increases have not been explained. Tables 1 - 3 describe the characteristics of the Carmel sewage outfall effluent.

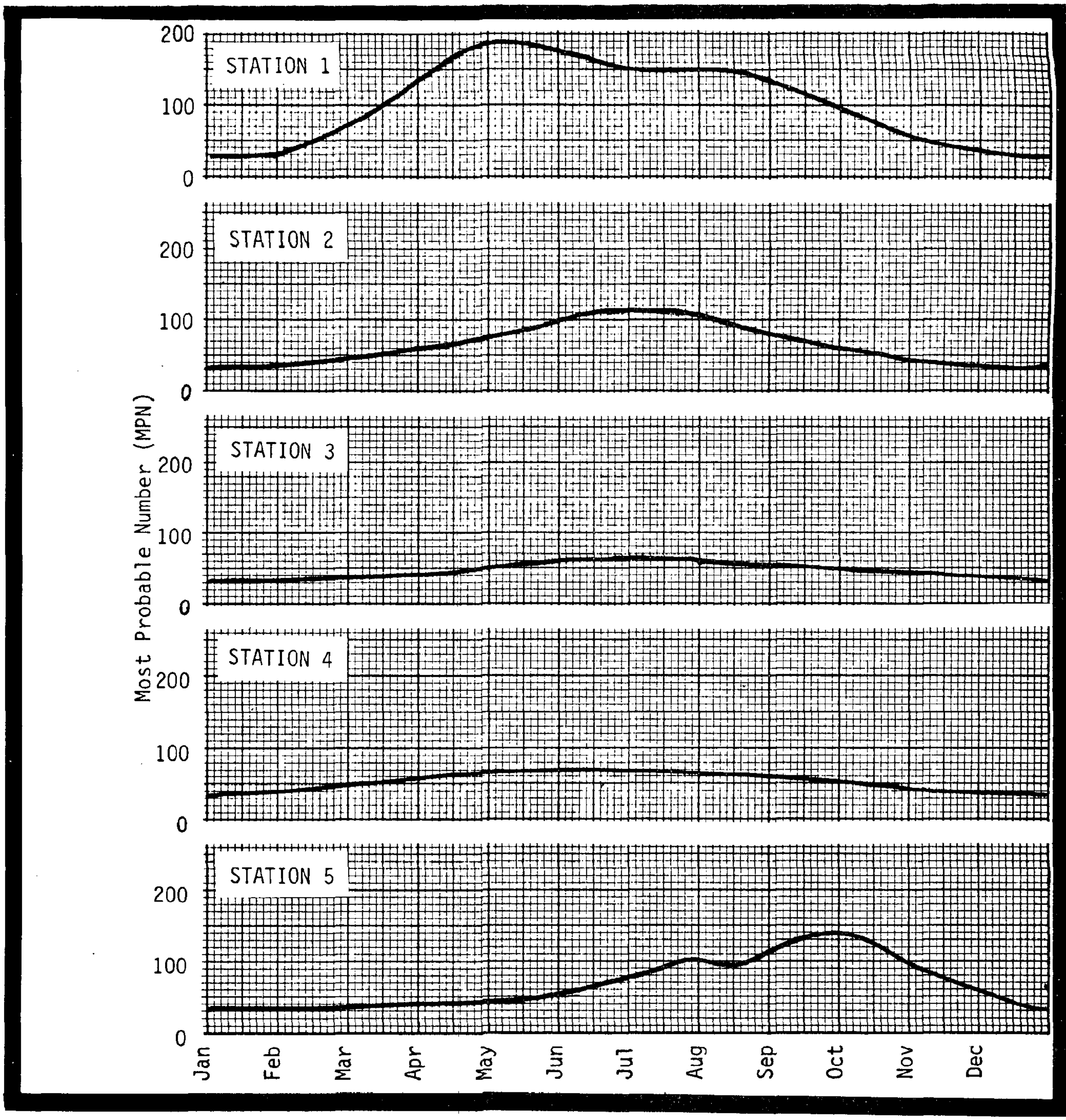


FIGURE 3: Typical Yearly Cycle for Coliform Bacteria at Stations 1-5, North Shore, Point Lobos Ecological Reserve. See Figure 2 for Station Locations. Source: Nichols, 1974.

TABLE 1: Carmel Sanitary District Average Effluent Characteristics, 1976

Month	BOD mg/l	Suspended Solids mg/l	NH_3-N mg/l	Floating Particles mg/l	Oil and Grease mg/l
January				<1.0	2.1
February	12	5	22.96	<1.0	2.9
March	22	6	17.36	<1.0	<1.0
April	18	9	20.16	<1.0	1.1
May	27	8	14.56	1.0	2.5
June	24	20	11.48	<1.0	1.0
July	15	20	13.44	<1.0	<1.0
August			20.72	<1.0	<1.0
September	28	15	9.52	<1.0	<1.0
October	19	10	14.0	<1.0	<2.4
November	31	6	22.4	<1.0	2.4
December			13.44	<1.0	<1.0
Average	27	18	16.96	-	-

Source: ESI, 1977.

TABLE 2: Pesticides, PCBs and Phenols in Carmel Sanitary District Effluent

Date	PCBs[1] ppb	Lindane ppb	Technical Chlordane ppb	Other Chlorinated Pesticides ppb	TICH[2] ppb	Phenolic Compounds ppb
5/10/76 8-hour composite	0.0002 .2	-	-	0.0002 .2	0.0002 .2	0.005 5
11/8/76 composite	<0.0001 <.1	0.00005 .05	0.00020 .2	<0.0010 <1	<0.0010 <1	<0.005 <5

[1]Polychlorinated biphenyls

[2]Total identifiable chlorinated hydrocarbons

Source: ESI, 1977.

TABLE 3: Level of Various Metals in Carmel Sanitary District Effluent (Concentrations in mg/l)

Date	As	Cd	Cr	Pb	Hg	Ag	Zn	Cn
5/10/76 8-hour composite	0.03	0.005	0.009	0.01	0.0002	0.01	0.094	0.05
11/8/76 composite	<0.01	<0.002	<0.001	0.01	<0.0002	0.01	0.066	<0.05

Source: ESI, 1977.

Geophysical Characteristics

General Description: The ASBS lies within the southern coast range geomorphic province of California. Three major formations are found within or adjacent to the ASBS (Figure 4).

a. Santa Lucia Porphyritic Granodiorite (Createaceous; 93 million years ago [mya]).

These rocks extend from a much larger formation in the core of the Santa Lucia mountain range (Figure 1), and consist of very large [up to 3"] (8cm) orthoclase crystals in roughly parallel orientation in a matrix of biotite, plagioclase, and quartz. When intruded into older sediments, the high temperature granodiorite transformed them into dark, finely laminated metamorphic rocks (schist and gneiss). Fragments of these older metamorphic rocks can be seen in the granodiorite. The top surface of the granodiorite was later heavily eroded and then the Carmelo formation was laid down upon it.

b. Carmelo Formation (Paleocene; 50-60mya).

This formation is composed of marine cobble conglomerate interbedded with sandstone and clay shale. It may have granodiorite inclusions. The cobbles come from an unknown volcanic source and lie within a matrix of often weathered quartz, feldspar and a clay-iron-calcium carbonate cement. The sandstone is a buff-colored material similar in chemical composition to the conglomerate matrix. In the upper parts of the formation, it forms substantial beds up to 40 ft. (12m) thick, while in the lower parts, it is present only in lenticular beds. Shales are more important in the lower formation; biotite, carbonaceaous material and sand make up this black rock.

The large, overhanging cliffs fringing the ASBS were formed and are maintained by undercutting caused by severe wave action working with the jointing planes in the granodiorite and the bedding planes in the Carmelo rocks. Water shoots back and up into these areas, causing continuous erosion. Boulders are found where wave action is rapid.

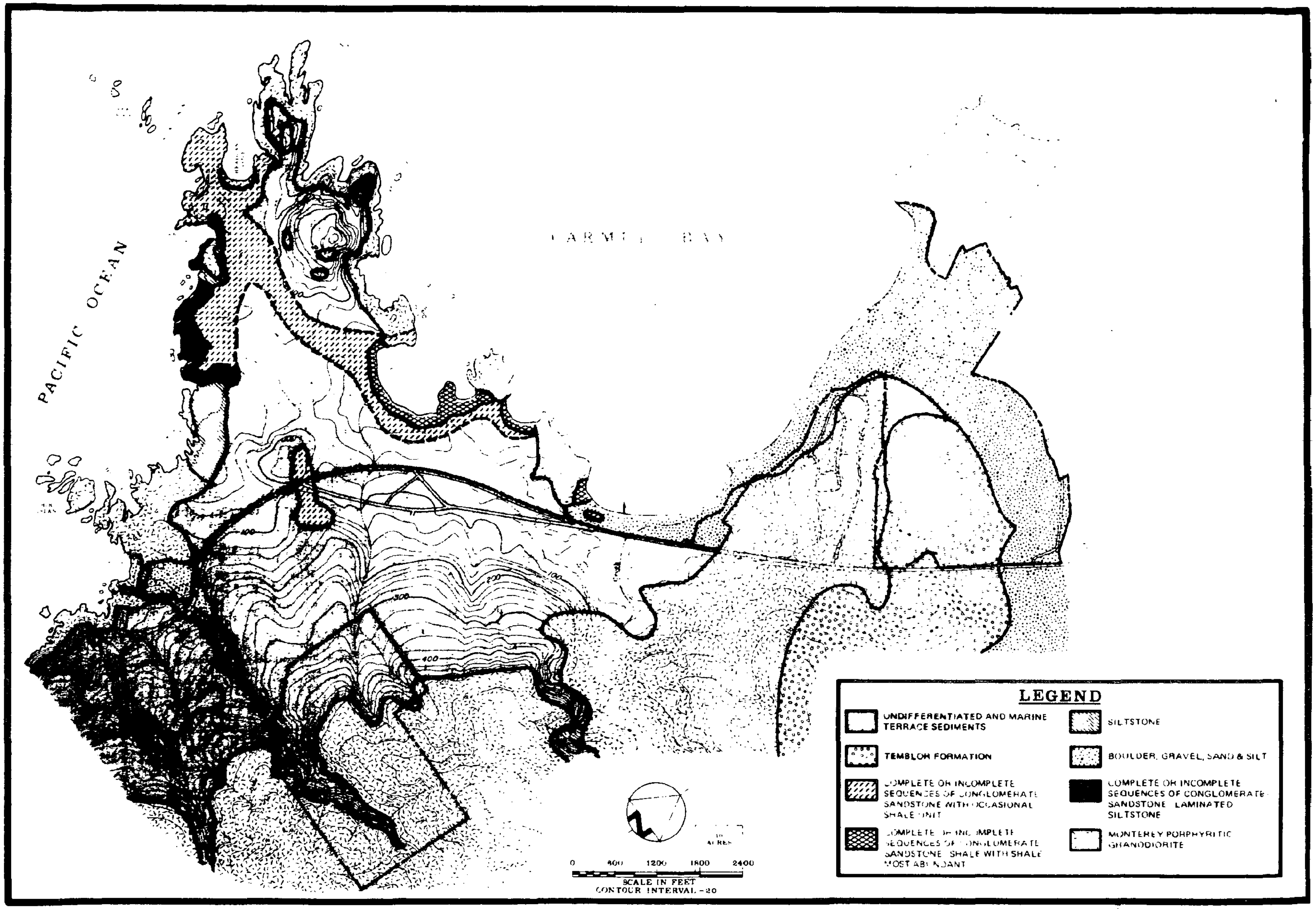


FIGURE 4: Point Lobos Ecological Reserve. Geology Map. Source: Department of Parks and Recreation, 1977.

Since the coast is currently rising, erosion is occurring throughout the ASBS. Eroded materials from cliffs and beaches do not accumulate on the shore, but are instead carried into Carmel Submarine Canyon or to the edge of the continental shelf.

The northern boundary of the ASBS consists of granodiorite rock which continues down the coast in steep cliffs to the north edge of Coal Chute Cove. Rocks of the Carmelo formation, containing thin laminae of sandstone and shale, continue down to the west side of Whaler's Cove, where the granodiorite reappears and continues to Headland Cove. The granodiorite here is being actively eroded by waves, by chemical changes in mineral composition and by temperature and moisture changes, making it a highly unstable substrate on which few organisms can survive. In Bluefish Cove, two large intertidal caves, open at both ends, run along small fault lines. The Carmelo rocks here have been eroded into shear cliffs.

The Carmelo Formation forms an almost continuous series of cliffs and platforms from Headland Cove to China Cove. A 75 ft. (23m) line of contact between the Carmelo above and the granodiorite below can be seen in a small cove just north of Headland Cove. Punta de los Lobos Marinos is made of granodiorite which contains a number of dikes - cracks filled with pegmatite and aplite formed during the cooling of the rocks. The Seal Rocks are made of highly resistant conglomerate. A narrow inlet on the conglomerate across the channel and east of these rocks is 150 ft. (46m) long and less than ten feet wide, causing water to shoot upward into the air through it. From this point down the coast 1,800 ft. (550m) are the least disturbed exposures of the Carmelo Formation, which are often studied as an index of past current and wave action.

Erosion of granite cliffs at China Cove is forming a very fine grained sand beach. In the clay shales at China Cove, neritic micro-fossils and occasional megafossils are found. Bird Rock is made of resistant granodiorite. Sandstone and shale form thin laminae in the cliffs of Gibson Beach just south of Gibson Creek. Calcareous sandstones at Gibson Beach contain fossils of marine molluscs and plant material.

c. Paso Robles Formation (Pleistocene; 2-5mya).

The land adjacent to the ASBS consists of three marine terraces and interterrace slopes of the Paso Robles Formation. The highest level is present only near the summit of Whaler's Knoll and possibly on the summit of Big Dome. The second, seaward sloping terrace forms the main and central part of the reserve and extends west to Punta de los Lobos Marinos. Wave formed, it undulates gently and may contain sand and gravel deposits 6-8 ft. (1.8-2.4 m) thick, as in the low ridge between Rat Hill and Whaler's Knoll. The third terrace appears intermittently along the north and west shores and shows little relief besides the hummocks found in the meadow east of Pebbly Beach (vegetation relics). Indian kitchen middens containing mollusc shells have been found in the soil overlaying the terraces and Bird Rock (100-1,000 years old). Figures 5 and 6 illustrate the topography of the land adjacent to the ASBS.

Historical Seismicity: Several major active faults occur within a hundred miles of the ASBS (Figures 7,8). The Cypress Point fault may be critical with respect to the Carmel sewer outfall, where a possible surface rupture could occur. Activities of these faults causing slides in Carmel Submarine Canyon could trigger tsunami waves with a run of 6 ft. (1.8 m), estimated to occur once every one hundred years (ESI, 1977). Figure 9 describes the magnitude of all earthquakes occurring within a hundred miles of the ASBS from 1911 to 1972.

Climate

Rainfall, air temperature and cloud cover are recorded daily by park rangers. Table 4 summarizes climatological data taken on the Monterey Peninsula from January 1952 through December 1977.

Strong north and northwesterly winds characterize the area in the spring and summer when the Pacific anticyclone (pressure cell) prevails. In the fall, the semi-permanent Pacific high weakens and moves southward.

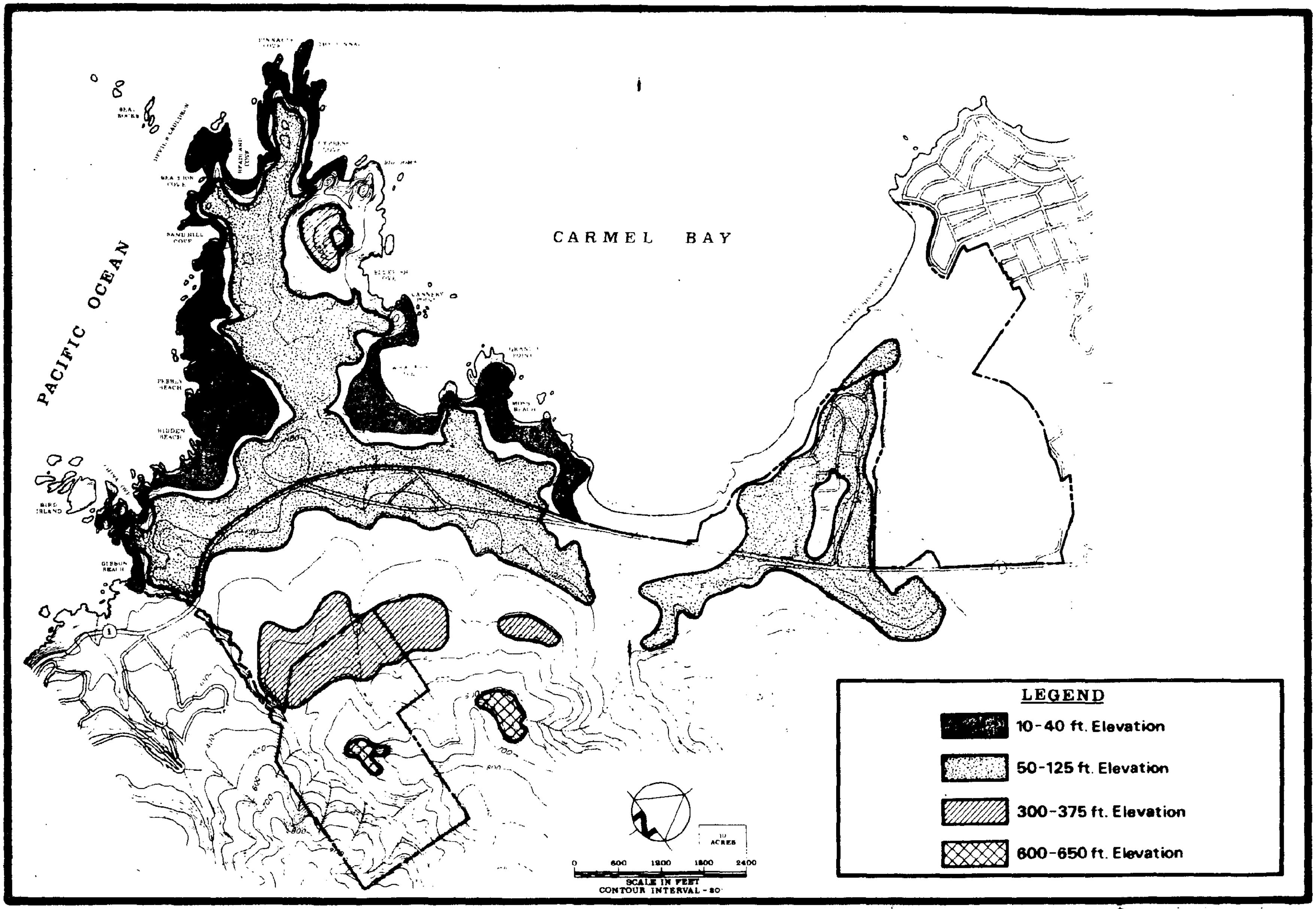


FIGURE 5: Point Lobos Ecological Reserve. Marine Terraces. Source: Department of Parks and Recreation, 1977.

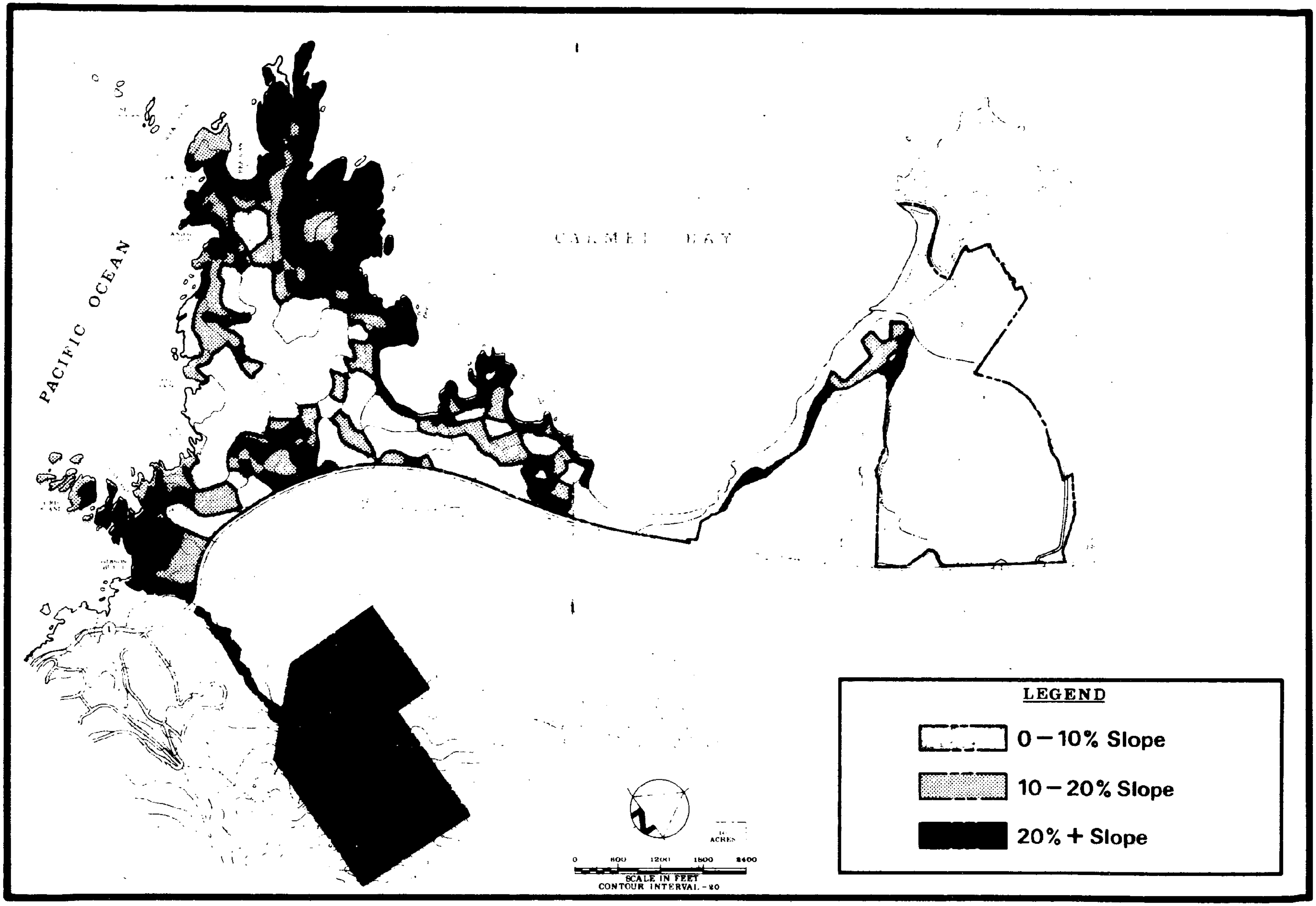


FIGURE 6: Point Lobos Ecological Reserve. Slope Map. Source: Department of Parks and Recreation, 1977.

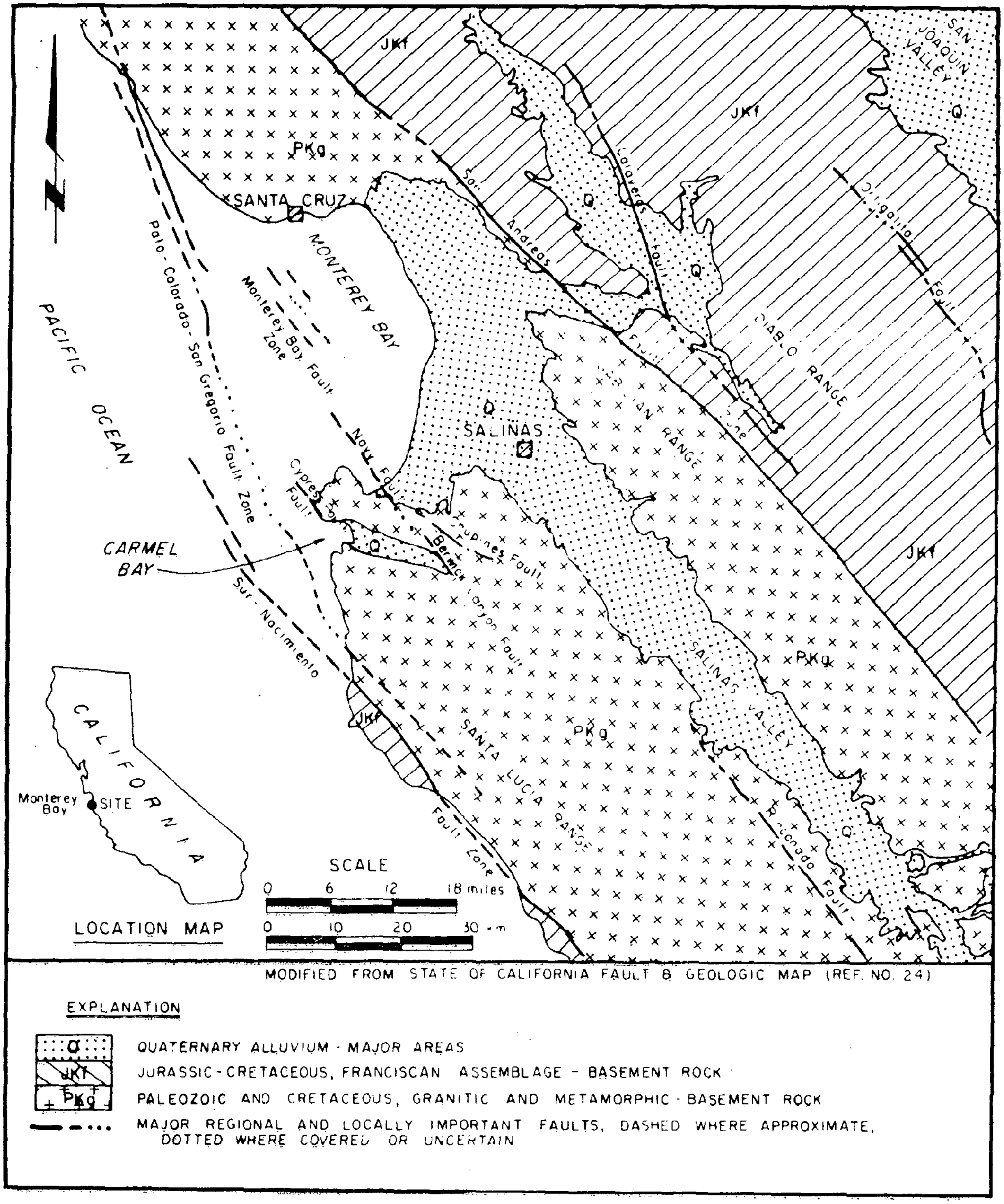


FIGURE 7: Carmel Sanitary District. Regional Geologic Map. Source: ESI, 1977.

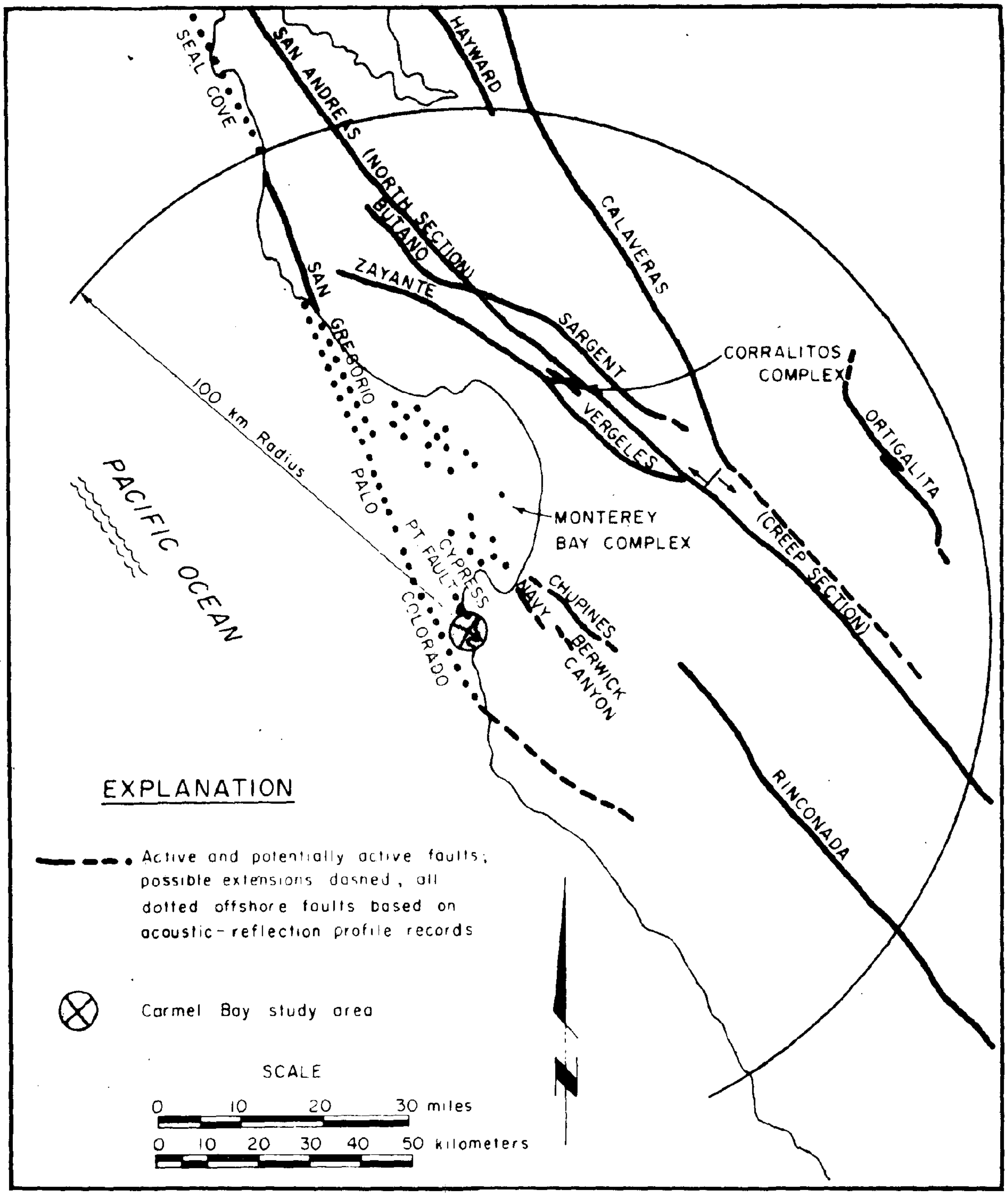


FIGURE 8: Carmel Sanitary District. Fault Map. Source: ESI, 1977.

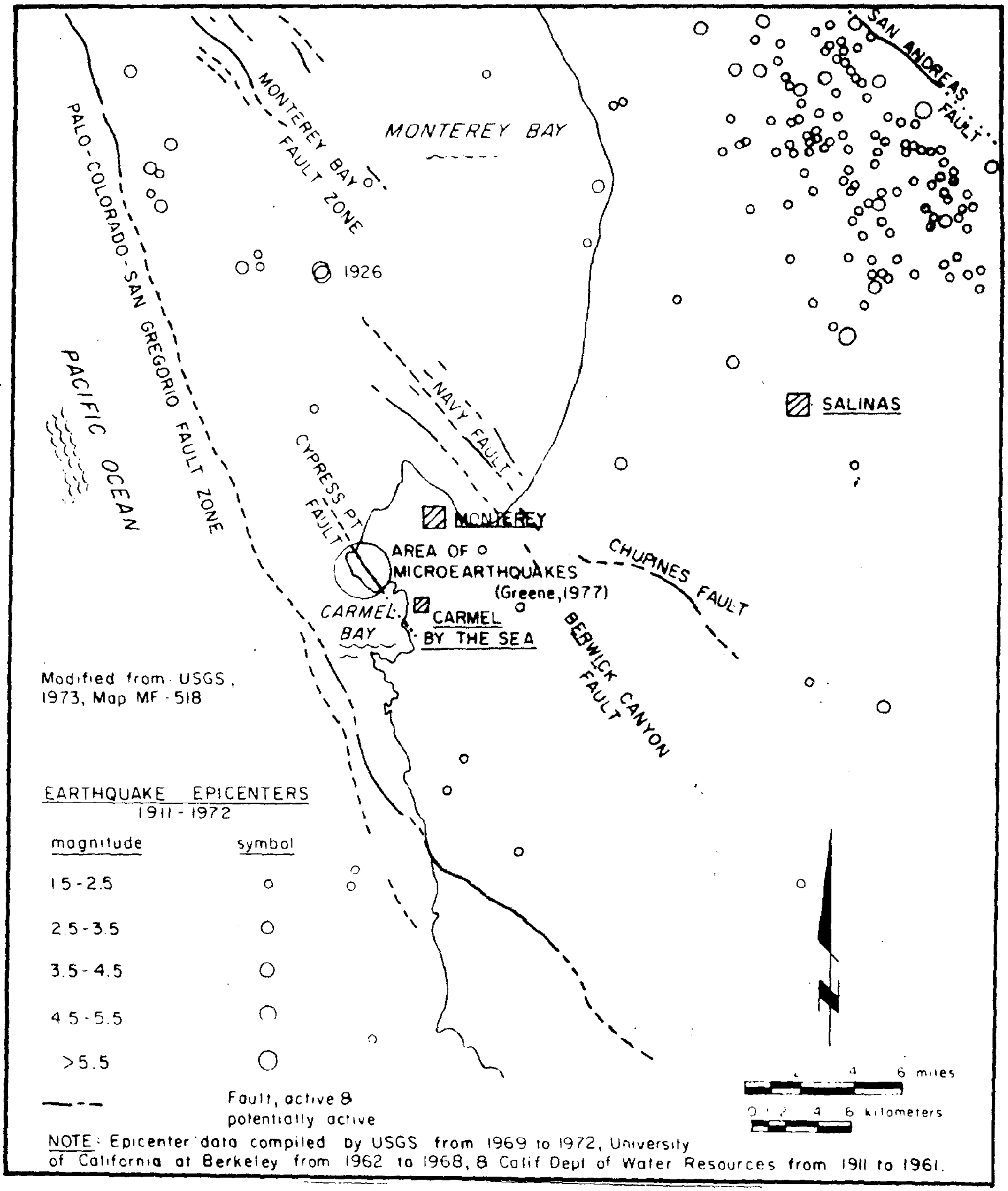


FIGURE 9: Carmel Sanitary District. Seismicity Map. Source: ESI, 1977.

TABLE 4: MONTEREY PENINSULA CA. WEATHER AVERAGES BASED ON 26 YEARS OF RECORDS (JAN 1952 THRU DEC 1977)
AT THE NATIONAL WEATHER SERVICE VOLUNTEER-OBSERVER CLIMATOLOGICAL STATION
MONTEREY, CALIFORNIA

Observer since Sep 1963: R. J. Renard
Elevation of observation site: 385 feet above sea level

MONTH	MONTHLY TEMPERATURES (degrees F)			DAILY TEMPERATURES (degrees F)				MONTHLY RAINFALL (inches)						Number of fog days**	Wind Speed□ (mph)
	Average Maximum	Average Minimum	Mean	Highest	Year	Lowest	Year	Average	Rain Δ Days	Wettest	Year	Driest	Year	Average	Average
Jan	60.0	42.6	51.3	84	62	27	62*	3.88	10	10.04	52	.18	76	6	5.0
Feb	61.7	44.2	53.0	85	54	27	62	2.54	9	7.31	69	.04	53	6	5.3
Mar	61.5	44.0	52.7	85	53	32	76*	2.56	9	7.17	58	.03	72	6	6.3
Apr	62.8	45.0	53.9	91	62	35	76	1.64	7	7.11	67	.04	77	7	6.8
May	64.1	47.5	55.8	95	76	39	52	.45	5	2.39	57	.01	75	13	7.2
Jun	66.9	49.9	58.3	101	61	42	62*	.21	3	1.56	67	T∇	61*	13	7.1
Jul	67.8	51.1	59.4	98	59	43	53*	.06	2	.28	66	T	62*	20	6.5
Aug	68.9	52.2	60.6	95	68*	45	56*	.13	3	.97	76	T	60*	21	6.1
Sep	71.9	52.5	62.2	101	71*	44	70*	.29	2	3.14	59	T	55	16	5.1
Oct	70.6	50.6	60.6	101	61	37	71	.68	4	2.46	72	T	59	14	4.6
Nov	65.8	47.0	56.4	95	56	35	64	2.25	7	6.49	65	T	59*	6	4.2
Dec	61.2	43.5	52.3	89	58	23	72	3.15	8	9.79	55	.37	75	7	4.4
Yearly Average	65.2	47.5	56.4				Total:	17.84	69					135	5.7

* and other years; most recent year shown

∇: T = trace of rain (i.e. less than .01")

□: averages from Naval Air Station records 1949-69.

Δ: Rain days = average number of days with rainfall .01" or greater

**: Fog day = day with visibility equal to or less than 6 mi for one or more hours (14 years of record). Monthly averages to nearest whole day.

Winds are weak and variable during this period of time. The Pacific high is replaced intermittently by a low pressure cell in the winter which brings westerly, southwesterly and southeasterly winds to the area.

Rainfall is heaviest from November through April and may occur only in minute traces from June through September. Average rainfall can vary appreciably from year to year with alternating periods of drought and heavy inundation. This may have a strong effect on the intertidal flora and fauna. During periods of drought, many of the higher areas of the intertidal zone are subject to great increases in salinity due to evaporation, while during the heavy rainfall, the salinity of the entire intertidal zone may be reduced considerably.

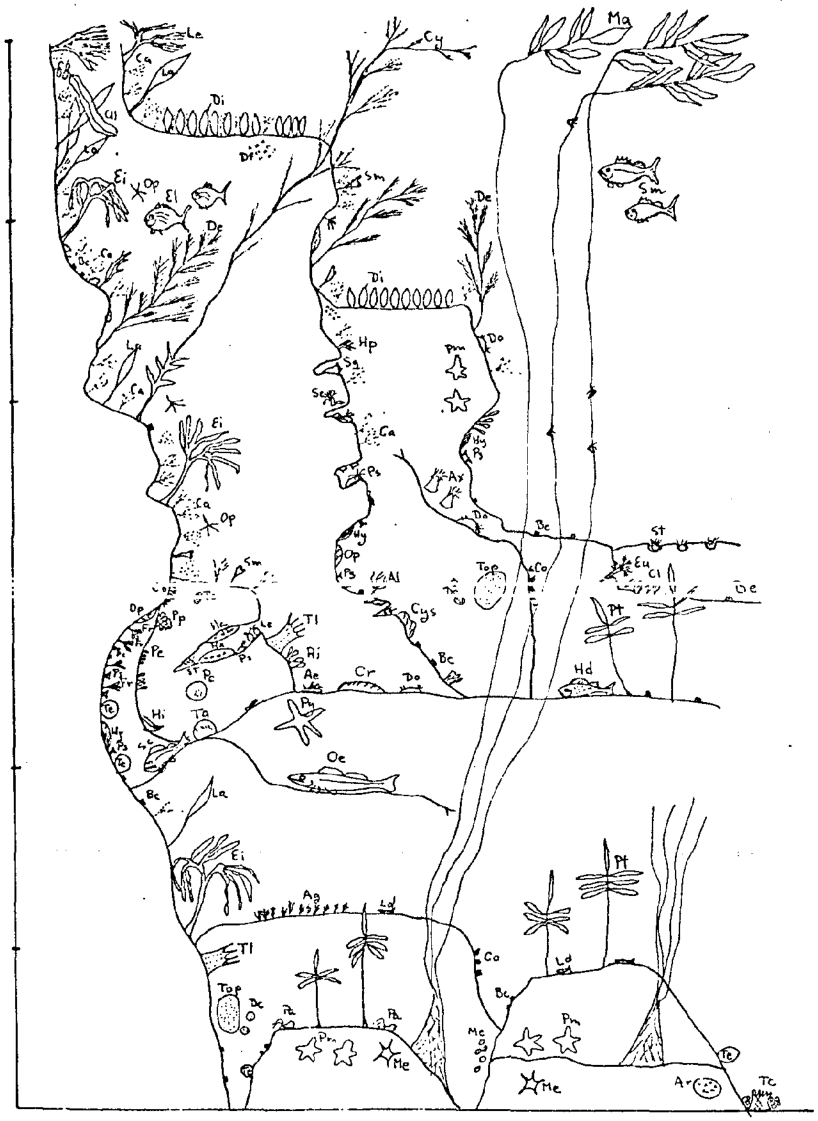
Chill from upwelling causes moisture in the air to condense into thick offshore fog banks which move onshore in a daily cycle. A nearly permanent fog bank hangs outside Whaler's Cove at this time. Fog provides additional moisture during the months of May through September when rainfall is minimal or absent. The fog tends to reduce average maximum air temperature during the summer months, causing year-round temperature fluctuations to be minimal compared to non-coastal environments. This summer fog accounts, in part, for the richness of the biota in the Monterey region, as it reduces desiccation of intertidal organisms during daytime low tides.

BIOLOGICAL DESCRIPTION

Subtidal Biota

Kelp Forests: Kelp forest assemblages (Figure 10a, Appendix 2) occur throughout the rocky areas of the reserve except at Stations 7, 13, 20 and 21. Numerous microhabitats within the kelp forest, including the blades and holdfasts of algae, the tops, sides and undersides of boulders, vertical rock walls, overhangs, crevices, cracks and caves are responsible in part for the highly diverse biota of this assemblage.

The dominant alga in this habitat is the giant kelp, *Macrocystis pyrifera*. This species is most abundant during summer. In winter, much of it is ripped out by storms. The bull kelp, *Nereocystis lutkeana*, occurs infrequently at several stations within the ASBS and *Cystoseira osmundacea* is often abundant in shallower areas of the kelp forest. All of these overstory algae have floats allowing their upper fronds to reach and cover large areas of the water surface. The next understory layer beneath this group is dominated by *Pterygophora californica*, extending from shallow water to the seaward edge of the kelp forest. *Laminaria dentigera* and *Eisenia arborea* are common on walls and sloping areas to about 50 ft. (15 m) depths. *Dictyoneurum californicum* occurs to about 40 ft. (12 m) depths on horizontal rocky surfaces. In shallow waters, a third understory layer is dominated by the articulated coralline alga *Calliarthron tuberculosum*, and also includes *Calliarthron cheilosporiodes*, *Desmarestia liqulata*, *Alaria marginata*, *Botryoglossum* sp., *Erythrophyllum delesserioides*, *Gigartina* sp., *Plocamium cartilagineum*, *Peyssonellia* sp., *Bonnemaisonia nootkana*, *Rhodymenia pacifica*, *Callophyllis flabellulata*, *Opuntiella californica*, *Weeksia reticulata*, *Prionitis lanceolata* and filamentous diatoms. Due to diminishing light, algal growth decreases with depth. Deeper portions of the photic zone contain *Fryeella gardneri*, *Calliarthron tuberculosum*, encrusting coralline algae, *Bossiella californica* ssp. *schmittii*, *Derbesia marina*, *Dictyota binghamiae* and *Fauchea laciniata*. *Mesophyllum conchatum*, *M. lamellatum* and *Nitophyllum cincinnatum* often occur as epiphytes on articulate coralline algae at all depths.



Brown Algae

Al = Alaria marginata
Cy = Cystoseira osmundacea
De = Desmarestia ligulata
Di = Dictyoneurum californicum
Ei = Eisenia arborea
La = Laminaria dentigera
Le = Lessoniopsis littoralis
Ma = Macrocystis pyrifera
Pt = Pterygophora californica

Red Algae

Ca = Calliarthron tuberculosum
Fr = Fryeela gardneri
Pr = Prionitis andersonii

Sponges

Hy = Hymenamphiastra cyanocrypta
Le = Leucandra heathi
Op = Ophlitaspongia pennata
Ta = Tetilla arb
Te = Tethya aurantia

Hydrozoans

Ag = Agla opnenia sp
Al = Allopora californica

Anthozoans

Ax = Anthopleura xanthogrammica
Be = Balanophyllia elegans
Co = Corynactis californica
Ps = Paracyathus stearnsi
Tc = Tealia coriacea
Tl = Tealia lofotensis

Polychaetes

Df = Dodecacaria fewkesi
Eu = Eudistylia polymorpha
Se = Serpula vermicularis

Chitons

Cr = Cryptochiton stelleri
To = Tonicella lineata

Prosobranch gastropods

Ha = Haliotis spp

Tm = Tegula montereyi

Opisthobranch gastropods

Do = dorid nudibranchs (Anisodoris

Opisthobranch gastropods (continued)

nobilis, Archidoris montereyensis, A. odhneri and Cadlina luteomarginata)
Ae = aeolid nudibranchs (Hermissenda crassicornis and Phidiana pugnax)

Bivalves

Hi = Hinnites giganteus
Pc = Pododesmus cepio

Crustaceans

Pa = Pagurus spp

Bryozoans

Hp = Hippodiplosia insculpta
Pp = Phidolopora pacifica

Asteroids

Me = Mediaster aequalis
Pm = Patiria miniata
Pg = Pisaster giganteus

Ophiuroids

Op = Ophiothrix spiculata

Echinoids

St = Strongylocentrotus purpuratus

Holothuroids

Ps = Psolus chitonoides

Tunicates

Ar = Archidistoma psammion
Cl = Clavelina huntsmani
Cys = Cystodytes lobatus
Dc = Didemnum carnulentum
Mt = Metandrocarpa taylori
Pe = Perophora annectens
Ri = Ritterella rubra
Sg = Styela gibbsii
Sm = Styela montereyensis
Top = Tridemnum opacum

Fishes

El = Embiotoca lateralis
Hd = Hexagrammos decagrammus
Ld = Lythrypnus dalli
Oe = Ophiodon elongatus
Sm = Sebastes mystinus

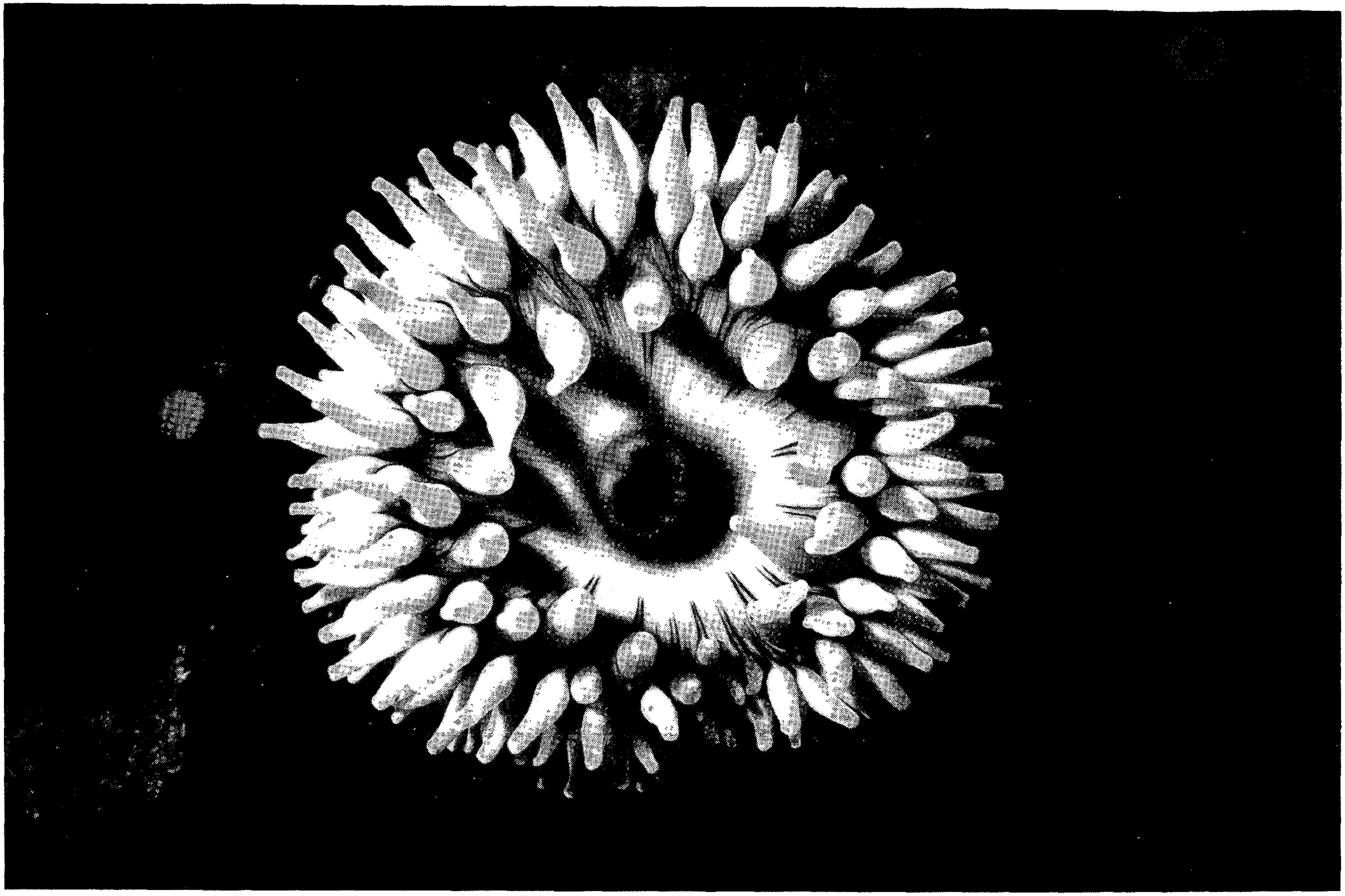
FIGURE 10a Point Lobos Ecological Reserve. Subtidal kelp forest assemblage. Source: DeMartini and Barry, 1977.

In the deeper areas where there is less light and therefore less algae, inverterbrates become more abundant. Strong water movements within the ASBS provide rapid replenishment of oxygen, nutrients, and food. These conditions probably contribute to the high abundance and diversity of sessile filter feeders. Sessile filter feeders are found throughout the kelp forest areas, but are found more often on vertical surfaces and in crevices than on horizontal surfaces. The boring sponge, Cliona celata, is often found boring into coralline algae. Numerous other sponge species feed on bacteria, phytoplankton, and detritus filtered from the water. Hymenamphiastra cyanocrypta, a bright blue colored sponge, is found only in areas of reduced light such as caves and overhangs. Sponges found predominately in crevices include Tethya aurantia and Stelletta clarella. Lissodendoryx noxiosa often is found with many worms, small molluscs and brittle stars living in its colonies. Other sessile filter feeders which may cover the rocks with vast colonies include hydroids, anemones, corals, bryozoans and tunicates.

The hydrozoa are carnivorous, capturing zooplankton with poisoned harpoons (nematocysts). Often, tops of boulders may be covered with waving colonies of Abietinaria spp. and Aglaophenia sp. The purple Allopora californica may form large branching colonies resembling coral and are common throughout the reserve. Phialidium sp. is often epiphytic on the alga Botryoglossum.

The anemones capture their food in the same fashion as the hydroids, but may capture larger prey including molluscs, sea stars and fish (Figure 10b). Anthopleura elegantissima, forming tight aggregations, and the solitary Anthopleura xanthogrammica are intertidal forms that occasionally extend into shallow subtidal areas. The delicate Clavularia sp. is found under ledges. The strawberry anemone, Corynactis californica, forms vast, tightly packed sheets which often dominate the vertical walls and caves within the ASBS.

Several coral species have been found within the reserve. Balanophyllia elegans is the dominant form in shallower areas, becoming very abundant



Photograph of the anemone _Tealia lofotenis_, found in the subtidal kelp forests.

on vertical rock walls. Below 30 ft. (10 m) depths Paracyathus stearnsi, a light-sensitive coral, may replace Balanophyllia and is often found in caves. Astrangia lajollaensis is a rare form which has been observed several times in the reserve, as has been Lophogorgia chilensis.

The bryozoa, filtering minute particles for food, are often found, with the exception of Retepora pacifica, on algae. Lichenopora radiata Crisia genicularа and Membranipora membranacea are found on the giant kelp, Laminaria dentigera and on bull kelp; Hippodiplosia insculpta occurs on Calliarthron spp.

Non-colonial sessile filter feeders include tube-dwelling polychaetes, brachiopods, sea cucumbers, brittle stars, and bivalves. Polychaetes filter plankton and detritus for food and may also filter mud and sand for tube building. Eudistylia polymorpha is found in narrow cracks on shallow vertical walls; Serpula vermicularis in cracks and on the sides of closely packed boulders. The sea cucumbers form burrows in cracks and algal holdfasts, and filter particulate detritus for food. Brittle stars are found under rocks and among growths of algae and hydroids.

A number of invertebrates in the kelp forest graze on live and decaying algae. These include prosobranch gastropods, chitons and abalones. Sea urchins are also important grazers. The purple urchin, Strongylocentrotus purpuratus, lives in pits in shallow areas and may be quite abundant. S. franciscanus is less abundant, but is sometimes found in crevices.

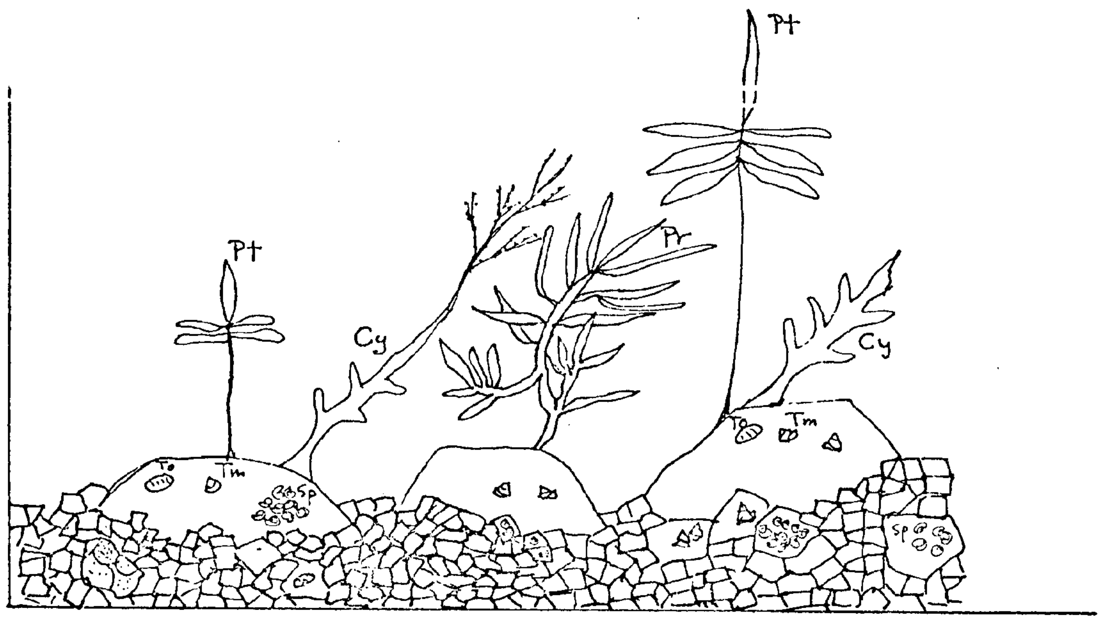
Nudibranchs are motile predators feeding on sessile filter feeders. Octopi, also important predators, are rarely seen and inhabit caves and deep crevices. The most important predators in the kelp forest, however, are the sea stars. Patiria miniata is the most ubiquitous, appearing in abundance at nearly all the stations. Henricia leviuscula is generally found among bryozoa and hydroids. Mediaster aequalis is a rare form found primarily in deep water.

The fish within the ASBS are found primarily within the kelp forest and are listed in Appendix 3.

Pebbly Habitat: The pebbly habitat assemblage (Appendix 4) occurs at Stations 7, 13, 20 and 21 (Figure 11). The coarse gravel, mussel shells and small cobble covering the bottom at these stations are continually rolled by heavy surge. Station 13 is relatively shallow [25-30 ft. (8-9 m)] and therefore receives the maximum amount of surge. As a result, the gravel is severly scoured and devoid of life. Stations 7, 20 and 21 are deeper [55 ft. (17 m)] and experience milder and less frequent surge. At these stations, pebbles are covered with encrusting coralline algae and the tiny tube-dwelling polychaete *Spirorbis moerchi* covers much of the mussel shells at Station 20. Juvenile turban snails, *Tegula montereyi*, and the burrowing anemone, *Tealia ciruacea*, occur throughout the pebbly habitat, and the omnivorous sea star *Patiria miniata* is fairly common.

The gravel bottoms at these stations are surrounded by vertical walls, large slump blocks and boulders. These substrata are prevented from developing a full kelp forest assemblage of organisms by continual scour from the gravel. Soft-bodied organisms such as sponges, hydroids, anemones, tube-dwelling polychaetes, nudibranchs and tunicates which may occur on vertical walls in the kelp forest are restricted in the pebbly habitat to protected areas such as crevices and undersides of boulders.

More durable animals such as the chiton *Cryptochiton stelleri*, the crab *Pugettia* sp., the keyhole limpet, *Diodora aspera*, and the limpet *Acmaea mitra* are less affected by scour. The sipunculid worm *Phascolosoma agassizii*, the red abalone, *Haliotis rufescens*, the hermit crab, *Pagurus* sp., the shrimp, *Spirontocaris* sp., and the brittle star, *Ophiothrix spiculata*, are generally found living in crevices and therefore survive successfully in this habitat. Although the sea star, *Patiria miniata*, is abundant at Stations 7, 21 and 22, the absence of most other sea star species may reflect the lack of organisms available to this predacious group in the pebbly habitat.



Brown Algae
Cy = Cystoseira osmundacea
Pt = Pterygophora californica

Polychaetes
Sp = Spirorbis moerchi

Chitons
To = Tonicella lineata

Prosobranch Gastropods
Tm = Tegula montereyi

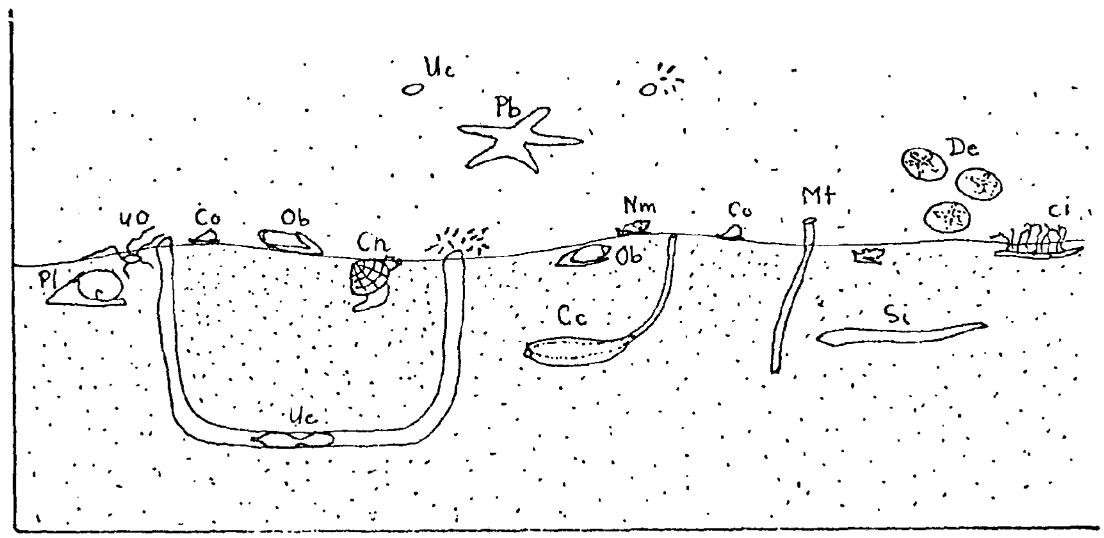
FIGURE 11: Point Lobos Ecological Reserve. Subtidal pebbly habitat assemblage. Source: DeMartini and Barry, 1977.

Sandy Habitat: Sandy habitat assemblages (Appendix 5) were observed in parts of Stations 2, 4, 16 and 22. The sand forms wide bands in the shallow subtidal zone and varies in texture from fine to coarse, depending on the frequency and force of wave action. Boulders are scattered within the sand at Stations 16 and 22.

Stations 2 and 4 are protected from heavy wave action during most of the year by narrow cove openings and by dense growths of giant kelp occurring at these openings. As a result, they contain the finest sands within the reserve and can support populations of weak burrowing and tubedwelling organisms (Figure 12), including the tube-dwelling polychaete, Mesochaetopterus taylori, the peanut worm, Spinunculus nudus, the inn-keeper worm, Urechis caupo (so called because of the variety of smaller organisms inhabiting its U-shaped burrow), the sea cucumber, Caudina chilensis, the clam, Clinocardium nuttallii, the moon snail, Polinices spp., the burrowing brachiopod, Glottidia albida, and the brittle star, Ophioplocus esmarki. Detritus feeders such as the prosobranch gastropods, Conus californicus, Nessarius mendicus, (carrying the commensal hydroid Hydractinia sp. on its shell) and the olive snail, Olivella biplicata, that is seen in shallower areas, scavenge over the surface. Also found on the surface are the sand dollar, Dendraster excentricus, the large California cucumber, Stichopus californicus, the scavenging crabs, Cancer spp., and the sea stars, Patiria miniata, Pisaster brevispinus, and Solaster dawsonii.

The coarse sand found at Stations 16 and 21 is formed by heavier wave action and supports a less diverse fauna than the finer sand areas (Figure 13). Rapidly burrowing species such as the tube-dwelling polychaetes, Diopatra ornata and Spiochaetopterus costarum, are common, as are the detritus feeding Nassarius mendicus and the olive snail.

Boulders within sandy areas provide a special habitat for attached biota (Figure 14). Scour from water-borne sand may eliminate the organisms on these boulders during heavy surge. Otherwise, while scour appears to keep the diversity of organisms to a minimum, these organisms which can survive the conditions may become abundant. The algae Gracilaria



Polychaetes
   Ci = cirratulid
   Mt = Mesochaetopterus taylori

Echiurids
   Uc = Urechis caupo

Sipunculids
   Si = Sipunculus nudus

Prosobranch Gastropods
   Co = Conus californica
   Nm = Nassarius mendicus
   Ob = Olivella biplicata
   Pl = Polinices spp.

Bivalves
   Cn = Clinocardium nuttallii

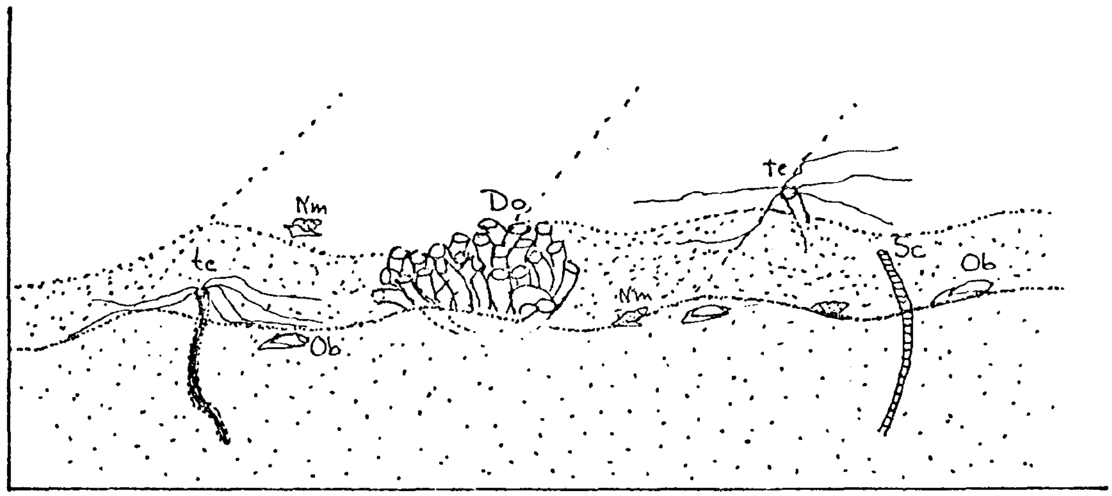
Asteroids
   Pb = Pisaster brevispinus

Ophiuroids
   uo = unidentified ophiuroid

Echinoids
   De = Dendraster excentricus

Holothuroids
   Cc = Caudina chilensis

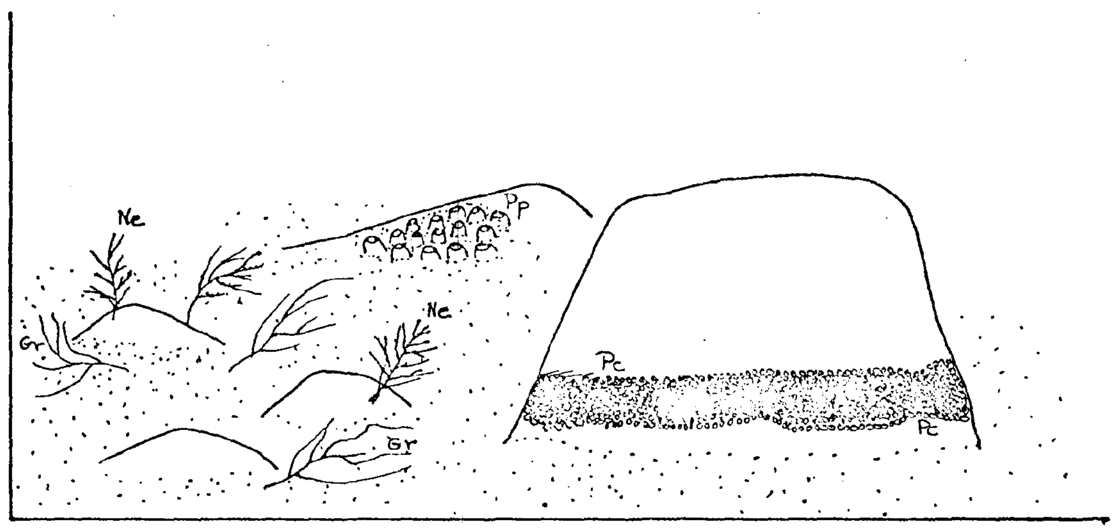
FIGURE 12: Point Lobos Ecological Reserve. Subtidal finer sand assemblage. Source: DeMartini and Barry, 1977.



Polychaetes
Do = Diopatra ornata
Sc = Spiochaetopterus costarum
te = terebellid

Prosobranch Gastropods
Nm = Nassarius mendicus
Ob = Olivella biplicata

FIGURE 13: Point Lobos Ecological Reserve. Subtidal coarse sand assemblage. Source: DeMartini and Barry, 1977.



Red Algae
Gr = Gracilaria sjoestedtii
Ne = Neoagardhiella baileyi

Sponges
Pp = Polymastia pachymastia

Polychaetes
Pc = Phragmatopoma californica

FIGURE 14: Point Lobos Ecological Reserve. Subtidal rock and sand assemblage. Source: DeMartini and Barry, 1977.

sjoestedii, Gymnogongrus spp., Neoagardhiella baileye and Prionitis andersonii often occur in this habitat. The sponge Polymastia pachymastia is found on sand-covered rocks and sends long siphons through the sand to receive water for filter feeding. The conditions in this habitat are ideal for the tube-dwelling polychaete, Phragmatapoma californica, which forms large encrusting colonies on the sides of boulders. Wave action transports sand grains up to the colonies and the worms cement the grains together to form their tubes.

Marine Mammals: A number of marine mammals can be found in the ASBS during various times of the year. Harbor seals give birth to their young during April at Point Lobos and may often be seen swimming or sunning on intertidal rocks with their pups. Sea Lion Rocks and Sand Hill Cove (Figure 2) are inhabited by Stellar and California sea lions. The Stellar sea lion calves in June and July. The bull and yearling California sea lions leave Point Lobos in July to travel to their mating grounds on the Channel Islands and return in August. From November through February, gray whales pass through the ASBS during their migration.

Sea otters play an important role in the ecology of the ASBS. By feeding on important grazers such as sea urchins, they may encourage greater algal growth. They also may disrupt sessile organisms by turning over boulders in search of food and thus exposing shade-dwelling forms and disrupting those living on boulder tops. Sea otters with pups have been observed within the ASBS at Sand Hill Cove, the second cove south of Sand Hill, China Cove, Gibson Beach and Carmel Bay.

Intertidal Biota

The intertidal region of the ASBS could generally be classified as open-coast rocky shoreline (Ricketts and Calvin, 1968). However, diverse habitats occur, including small pocket beaches, exposed rocky areas, protected rocky areas, tidepools and sheer cliffs.

Pocket beaches occur within the ASBS at Whaler's Cove, Sand Hill Cove, Hidden Beach, China Cove and Gibson Beach. The pocket beaches contain only those animals and plants which can burrow and tolerate continual shifting sand. Zonation is not as distinct as in rocky areas. The sand flea, Orchestoidea spp., inhabits upper levels of the sand beneath piles of decaying seaweed. The sand crab, Emerita analoga, is found further down in the littoral zone. Littorina planaxis and L. scutulata (gastropods), Collisella spp. (limpets) and Ligia occidentalis (isopod) are occasionally found in the splash zone on beaches with large pebbles and boulders. An example is Pebbly Beach.

The exposed rocky areas support a rich flora and fauna in the highly oxygenated water produced by the pounding surf. Most inhabitants of this zone have adapted to resist the impact of heavy surf without being crushed or swept away. Biota of this area are discussed below in greater detail according to the zonation pattern of Ricketts and Calvin, 1968 as follows.

Zone 1. Animals of the uppermost rocky beach wetted in its upper reaches by waves and spray only and in its lower part by high tides only.

Zone 2. Animals of the high-tide region, from mean high water to about mean higher low water.

Zone 3. Fauna of the mid-tide region, from about the mean of higher low water to the mean of lower low water, the zero of tide tables (plus 2 1/2' to 0 at Monterey).

Zone 4. Low-tide region: Normally uncovered by "minus" tides only, and extending from 0 to -1.8' or so at Pacific Grove.

Spray produced by the heavy surf creates an upward extension of the area covered by Zone 1. Many molluscs inhabit this zone; they are able to withstand wave action and avoid desiccation by creating suction within their shells and clamping down on the substrate. Littorina planaxis is common, along with Collisella digitalis, C. pelta and, the owl limpet, Lottia gigantea. The barnacle Chthamalus sp. and the acorn barnacle, Balanus glandula, also occur. They are firmly cemented to the rocks and are able to close their tightly-fitting opercular valves to prevent dessication.

Zones 2-4 tend to have similar biota in the wave exposed intertidal zone, since heavy spray and splash reach all three zones on all but the lowest tides. These zones are dominated by large beds of California mussels, Mytilus californianus, which anchor themselves to rocks with strong byssal threads and have heavy shells as protection against the surf. Within the beds are patches of the goose barnacle, Pollicipes polymerus. Both animals feed by filtering plankton from sea water. Acorn barnacles and Chthamalus frequently cover the mussels and a small, unidentified limpet often lies camouflaged on the goose barnacles. Within the shelter of the mussel/goose barnacle beds live flatworms (some predatory on barnacles), the nemertian, Emplectonema gracile, the polychaete Nereis spp., the scale worm, Halosydna brevisetosa, sipunculids, isopods, Idothea spp., amphipods, shrimps, pea crabs and procelain crabs, Petrolisthes sp. Mussel beds are readily observed at Granite Point, Cypress Cove and Punta de los Lobos Marinos.

In areas not dominated by these beds, such as the mouth of Coal Chute Cove, colonies of the worm, Phragmatopoma california, may form large honey-combed structures built of sand cemented tubes. Sponges and the rock crab, Pachygrapsus crassipes, often occupy holes in these colonies for shelter.

The remaining stretches of rock are sprinkled with acorn barnacles, Chthamalus, tiny tube-dwelling spirorbid polychaetes, keyhole limpets, Collisella spp. and occasional hydroids. The chitons Katherina tunicata, Mopalia ciliata, M. mucosa and Cryptochiton stelleri are also present. Several predatory animals inhabit this area. The sea star, Pisaster ochraceus, feeds on mussels, goose barnacles and limpets. The gastropod, Thais sp., feeds on mussels by boring holes in their valves, while Acanthina spirata prefers barnacles. In the lower areas, the purple urchin may carve numerous holes into the substratum. Algae include the Sea Palm, Postelsia palmaeformis, Egregia menziesii, Laminaria dentigera and a variety of encrusting and articulated corallines.

Protected rocky areas, such as Coal Chute Cove, Whaler's Cove, Bluefish Cove and Pebbly Beach, are found where a rock formation has partially blocked the entrance of an inlet or cove. Zone 1 is usually devoid of algae except for occasional patches of Endocladia muricata. Littorina planaxis and L. scutulata, the barnacle Chthamalus sp. and the acorn barnacle, and Collisella spp. are found on rocks in this zone. The wrack at the high tide line contains the beach hopper, Orchestoidea spp. Underneath large stones and boulders, a number of flatworms may be present, including Polychoerus spp. and Notoplana spp.

In Zone 2 on the tops of rocks, algae includ sea lettuce, Ulva spp., spots of encrusting Ralfsia spp., Corallina spp., Porphyra spp., Bangia fusco- purpurea and Enteromorpha spp. The black turban snail, Tegula funebralis, Collisella spp. and the keyholde limpet, Fissurella volcano, appear on surfaces covered lightly with barnacles and patches of Spirorbis spp. In this zone, the biota frequent cracks and depressions which contain small reserves of moisture. Cladophora columbiana, Ceramium sp., Rhodoglossum affine, Gelidium sp., Endocladia muricata and Pelvetia fastigiata are common algae in these habitats.

Cracks may be heavily lined with the cloning anemone, Anthopleura elegantissima, the black turban snail, barnacles and limpets. Long dark polychaete feeding tentacles often extend from the smallest cracks. Amphipods, isopods, flatworms, brittle stars and the procelain crab, Petrolisthes cinctipes, live underneath rocks here.

Zone 3 is characterized by heavy algal cover, including Iridaea flaccida, sea lettuce, Egregia sp., Cryptopleura sp., Gastroclonium coulteri, Gelidium spp. and Neoagardhiella baileyi. Colonies of Anthopleura elegantissima form vast sheets in this area. Barnacles, limpets and the chiton Nuttallina californica and the lined chiton, Tonicella lineata, are also found here. Pisaster ochraceus, the bat star, Patiria miniata, and Leptasterias spp. (with six rays) are common predators. Dorid nudibranchs appear among algal fronds.

Zone 4 contains the surf grass, Phyllospadix spp., and the algae Iridaea cordata, encrusting and upright corallines Cystoseira osmundacea, Codium fragile, Laminaria dentigera, and Egregia sp. Common predators include the sunflower star, Pycnopodia helianthoides, Leptasterias spp., Henricia leviuscula, the leather star, Dermasterias imbricata, and the gastropod, Thais spp. The black turban snail, the brown turban snail, Tegula brunnea, Astraea gibberosa, Collisella spp., Cryptochiton stelleri and the chiton, Katharina tunicata, are the major grazers in this zone. Purple urchin excavations and rock ledges provide habitat for a variety of filter feeding sponges, hydroids, bryozoans and tunicates. The black abalone, Haliotis cracherodii, may occur in dense aggregations (one crevice contained 48 individuals) and the red abalone, H. rufescens, may also be present.

Tidepools vary from the subtidal zone in that the water in the pools may undergo extreme variations in temperature, oxygen and salinity. They harbor many of the biota already mentioned and additional forms preferring inundation.

Zone 1 tidepools exist at Point Lobos in high relief areas. These may become very saline from evaporation or may be filled with fresh water during rains. Little else survives in these pools besides patches of Endocladia and the tiny copepod, Tigriopus californicus.

Tidepools in Zones 2 and 3 support a variety of organisms. Plants include corallines, Iridaea sp., Flaccida sp., Prionitis lanceolata, and, in the lower areas, surf grass. Abundant hermit crabs, Pagurus spp., scavenge in these pools along with the rock crab, Pachygrapsus crassipes, the purple shore crab, Hemigrapsus nudus, and an occasional Cancer sp. Pisaster ochraceus and Leptasterias spp. are common predators. The black turban snail is an extremely abundant grazer, often carrying the slipper shell, Crepidula adunca, and Collisella asmi on its shell. Nudibranchs are often found among the algae or suspended from the surface of the pools. Sculpins and clingfish dart among rocks or lie among corallines where their protective coloration makes them nearly invisible.

The lowest pools may be filled with the purple urchin and the giant red urchin, Stronglylocentrotus franciscanus, which are preyed upon by the sunflower star. Anthopleura xanthogrammica is common in these pools, along with occasional solitary A. elegantissima. These anemones may provide shelter for pycnogonids. Low intertidal pools also contain the strawberry anemone, Corynactis californica, and the anemones Epiactis prolifera and Tealia crassicornis. These pools also contain the corals Balanophyllia elegans and Allopora porphyra, several species of nudibranchs and many types of hyrdroids with their commensal caprellids. As in higher tidepools, Pagurus spp. and the lined shore crab, Pachygrapsus crassipes, are common scavengers. The black turban snail is partially replaced by the brown turban snail at this level, and Calliostoma spp. is occasionally seen.

Shrimps are common under rocks, along with ophiuroids whose tiny articulated arms may be seen searching the water for small prey. The low pools and their inhabitants may be covered with encrusting red algae and also contain many corallines, surfgrass, Laminaria sp., Egregia sp. and Crystoseira sp. The lined shore crab and the porcelain crab, Petrolisthes cinctipes, are abundant scavengers and scurry under rocks at the slightest movement.

The intertidal cliffs within the ASBS occur at Cypress Cove, The Pinnacle, North Point, South Point, Punta de los Lobos Marinos and Bird Island. The splash zone extends far up the cliffs due to the severe wave shock these areas receive. Cladophora sp. and encrusting coralline algae occur in patches, along with lichens, barnacles and limpets. In Zone 2, the algae Endocladia muricata and Ralfsia sp. appear, and the barnacles and limpets (including the large territorial owl limpet, Lottia gigantea) become more abundant. Iridaea chordata and Egregia menziesii, along with juvenile sea palms and articulated coralline algae are dominant algae in Zone 3, where limpets, barnacles and occasional chitons are extremely abundant. In Zone 4, algae include adult sea palms, which encrust coralline algae Alaria marginata and Laminaria dentigera. Large owl limpet territories occur here occasionally, but the fauna is dominated by the mussel/goose barnacle complex and by the procelain crab and the lined shore crab.

Landside Vegetation

Detailed information on land vegetation is available in Drury (1970), ESI (1977), Barry, et al (1977) and Point Lobos Advisory Committee (1936).

Point Lobos Ecological Reserve contains one of the two known naturally occurring groves of Monterey Cypress, Cupressus macrocarpa, in the world. Close to 600 species of native wild flowers flourish within the reserve. These include California poppies, buttercups, creamcups, Brodiaea spp., blue lupine, Ceanothus spp., indian paintbrush, wild roses, shooting stars and wild violets.

North of the cypress groves along the headlands of Carmel Bay, the flora of Point Lobos Ecological Reserve includes pine forests in the areas back from the ocean, meadow flora, a ruderal flora on formerly tilled lands, sandhill flora and a sea bluff flora. Figures 15 and 16 illustrate the flora of the reserve in more detail.

Within those floral communities directly bordering the ASBS, a variety of lichens and succulents can be found, particularly in the Monterey cypress and Monterey pine groves. The lower branches of these trees may also harbor a colorful green alga which is red in appearance.

Unique Components

The Point Lobos ASBS includes a variety of habitats and organisms. This high diversity within a relatively small area may be unique. The horny coral, Lophogorgia chilensis, reaches its northerly limit in the area and the southern sea palm, Eisenia arborea, occurs around Point Lobos but not for many miles north or south.

Another unique component of the ASBS is the depth to which the giant kelp occurs (well below 100 ft. [30 m]). This has been attributed to the extreme water clarity of the ASBS, which lowers the depth of the photic zone.

The marine mammal pupping grounds, while not unique to the ASBS, are not common elsewhere and should be regarded as a special feature.

Point Lobos ASBS is also remarkably unique in the huge numbers and diversity of sessile filter feeding invertebrates (sponges, hydroids, anemones, corals, bryozoa, entoprocta, brachiopoda, tube-dwelling polychaetes, sea cucumbers and tunicates). This feature is probably related to the water quality within the ASBS, but further study is needed.

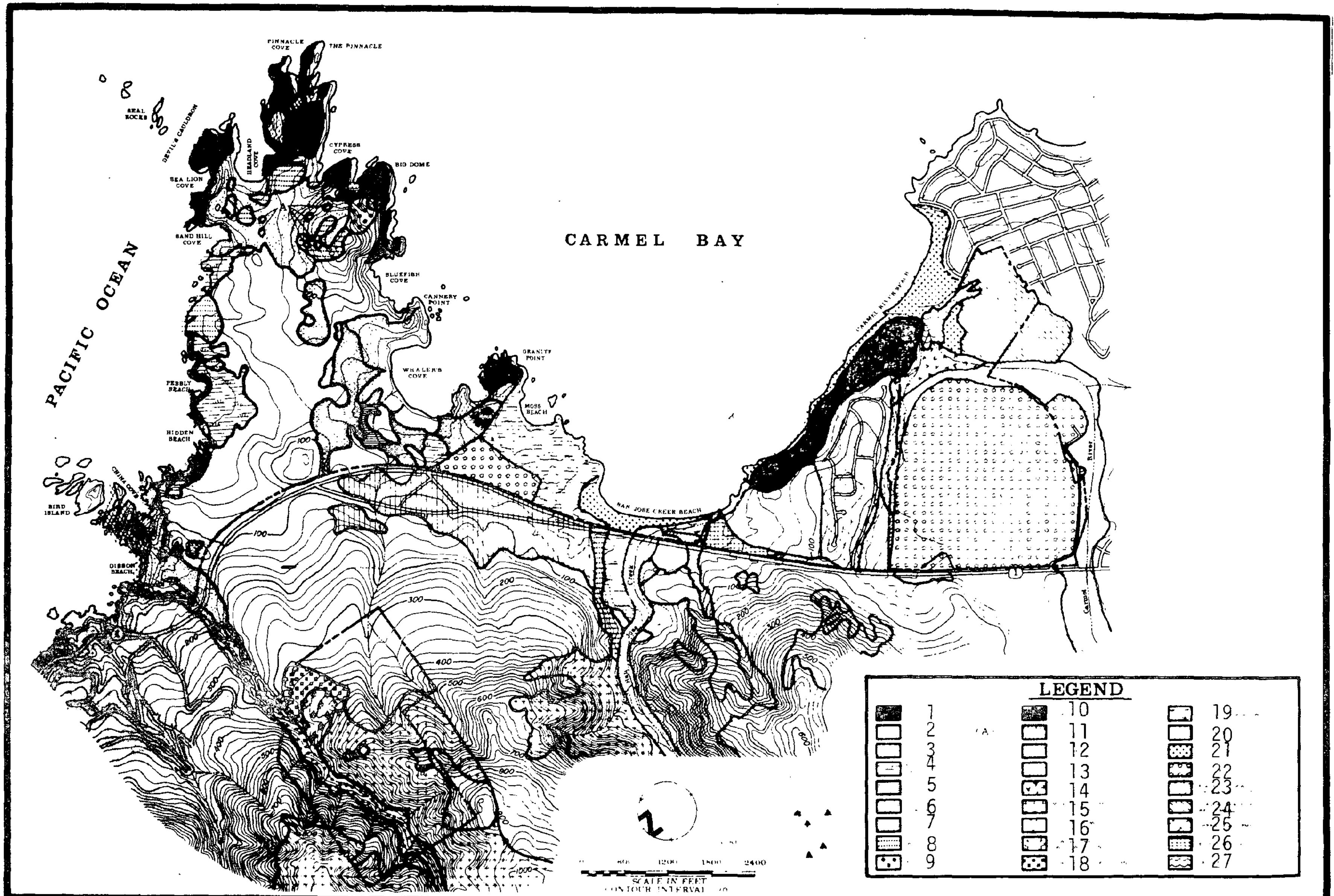


FIGURE 15: Point Lobos Ecological Reserve. Land Vegetation. Source: Department of Parks and Recreation. 1977.

Legend for Figure 15: Land Vegetation. Point Lobos Ecological Reserve

1 Monterey Cypress forest
2 Monterey Pine forest
3 Introduced annual grassland
4 North coastal prairie (w/Deschampsia-stipa tall grass)
5 North coastal prairie (Distichlis variant)
6 California sagebrush coastal scrub
7 Coyote brush coastal scrub
8 Wild lilac coastal scrub
9 Poison oak coastal scrub
10 Coastal bluff
11 Wild buckwheat coastal scrub
12 Bush lupine coastal scrub
13 Mixed coastal scrub
14 Riparian herb
15 Manzanita-Chamise coastal chaparrel
16 Coastal redwood riparian forest
17 Gowen Cypress dwarf woodland
18 Gowen Cypress woodland
19 Grass-herb meadow
20 Irrigated pasture
21 Coastal strand
22 Cultivated agriculture
23 Black Cottonwood riparian woodland
24 Coastal brackish water marsh
25 Urban development
26 Blue Gum Eucalyptus grove
27 Lagoon

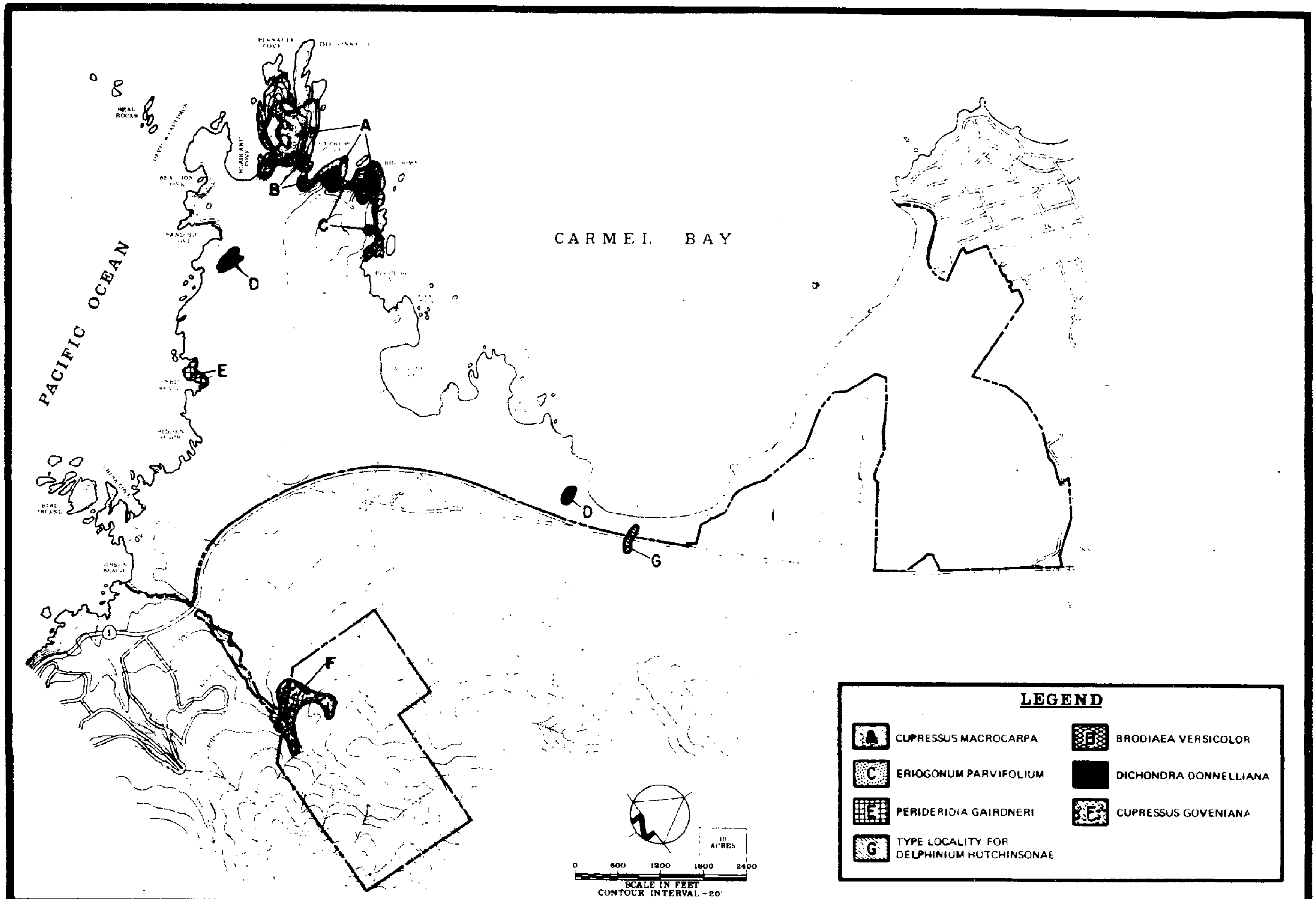


FIGURE 16: Point Lobos Ecological Reserve. Rare and Endangered Plant Species. Source: Department of Parks and Recreation, 1977.

LAND AND WATER USE DESCRIPTION

Marine Resources Harvesting

No commercial or sport fishing, kelp harvesting or mineral mining is permitted within the marine reserve. Occasional commercial fishing and more frequent sport fishing occurs within the ASBS, since the offshore boundaries are not marked and are somewhat irregular. Buoys have been obtained by the Department of Parks and Recreation to mark the area, but they have not yet been installed. Continued use of the ASBS by commercial and sport fishermen could affect the biota directly by reducing populations of some species and indirectly through waste discharges from the vessels.

Municipal and Industrial Activities

No municipalities or industrial activities exist in or within one mile of the ASBS. Whaling, coal mining, and abalone canning industries were present within the ASBS until the turn of the century.

Agribusiness and Silviculture

Cattle were raised on the Hudson property just north of Point Lobos until the beginning of 1977 (Figure 2). Reduced ground cover caused by cattle grazing may have caused erosion of terrestrial materials into the ASBS. Horses graze on the Hudson property directly east of Highway One (Figure 2). Waste products and eroded terrestrial material may enter the ASBS via the runoff from San Jose Creek.

No logging operations occur within or adjacent to the ASBS.

Governmental Designated Open Space

Point Lobos was purchased from the Allan family in 1933 and opened to the public as a 1,250-acre (500 ha) state reserve in 1935. In 1960, the state purchased 750 submerged acres (300 ha) of land surrounding the point and created the first underwater reserve in the United States. Point Lobos was designated a Registered National Landmark by the National Park Service in 1968 and received ecological reserve status in 1973, whereby all flora and fauna are protected in order to maintain a natural environment. Recently, 48 acres (19 ha) have been added to the reserve with the purchase of the Hudson property west of Highway One (Figure 2).

A new general plan for the reserve is being drawn up by the State Department of Parks and Recreation. The following policies are being considered at this time, but have not yet been adopted by the Parks and Recreation Commission:

a. Restricting all vehicles to one parking lot and using a shuttle to transport people around the reserve.

b. Using the Hudson House (Figure 2) as a visitors' center.

c. Restricting the number of people entering the park at one time and encouraging advance reservations.

d. Periodic trail re-routing.

e. Eliminating all SCUBA diving.

Recreational Uses

Recreational use of Point Lobos Ecological Reserve is increasingly discouraged by the State Department of Parks and Recreation. Twenty picnic tables are scattered throughout the reserve, most of them immediately adjacent to the intertidal zone, and a plan to remove them all is now being considered by the Department. No barbecues or open fires of any kind (including cigarettes) are allowed in the reserve. Visitors are not allowed to collect, remove or even disturb any object in the reserve, including flowers, driftwood, rocks and shells, and are encouraged to remain on trails. The park closes at sunset and no overnight camping is allowed.

There are two to three miles of paved road in the reserve. The number of vehicles present at any one time depends partially on how people park. Only one of the nine parking lots (at Cypress Cove) has marked parking spaces. Park rangers feel that this is a problem, as it encourages people to park on unpaved land, especially at the Bird Rock and Whaler's Cove parking areas. The estimated total capacity for vehicles is 155. On weekends and during the period between late July and early September, the reserve may reach full capacity and be closed to vehicles up to four times a day. When this occurs, additional vehicles are parked on Highway One. There is a strong possibility that vehicles will be prohibited from the reserve entirely when the new general plan goes into effect. In this case, trams may be used to transport people throughout the reserve.

During the 1976-77 fiscal year, 311,908 people visited Point Lobos. An estimated 1,800 people may visit the park on peak days, especially during weekends. Attendance may drop to 100-500 persons per day during the week from December to February (particularly the week before Christmas) and during bad weather. Heavy use by school groups (1-4 bus loads per day) occurs during April and May.

Nature study is the principle recreational use of the Point Lobos ASBS. The park rangers give two nature walks each day, which are attended by 1-40 people. The walks highlight special features of the reserve and emphasize the importance of regulations in maintaining the environment. The park rangers cover many aspects of natural history and describe the area's early history.

The Department of Parks and Recreation estimates 20,534 individuals hiked reserve trails in 1976. There are 7.3 mi. (11.8 km) of trails in the reserve, many of them bordering the ASBS (Figure 2). Bicycling is limited to paved roadways and 1,765 cyclists used them in 1976. Swimming is restricted to China and Gibson Beaches. The park is used heavily by artists and photographers. In 1933, 61 artists registered with park headquarters and the number has increased steadily since then.

Sport diving is not allowed, but diving for scientific, educational and photographic purposes is allowed at Whaler's and Bluefish Cove. Special permission is required for scientific diving in other areas. Ten teams (20-30 divers) are allowed in the water at one time. This restriction is based primarily on the limited parking facilities at Whaler's Cove, the only access point for divers. The number of divers often reaches the allowed maximum on weekends throughout the year, with lower diver use on weekdays. In 1976, 4,817 diver days were logged. Dive boats, such as inflatables and kayaks, are the only boats allowed in the reserve for other than scientific work. Five or ten may be present during peak periods, which include most weekends and week days between Memorial Day and Labor Day. Boats are launched at Whaler's Cove only.

Scientific Study Uses

Why?

Scientific studies in the ASBS have been minimal due to the difficulty of obtaining collecting and use permits. Existing studies are listed in the bibliography. The Park Service reports that other unpublished studies have been done, but that they rarely receive the resulting information. A better estimate of scientific use would be available if all scientific users informed the Park Service of their presence.

Transportation Corridors

U.S. Highway One lies immediately adjacent to the reserve, but is not visible from the ASBS (Figures 1, 2). Shipping lanes are approximately seven miles offshore from the ASBS. The nearest railway is approximately twenty miles east of the ASBS through the Salinas Valley.

ACTUAL OR POTENTIAL POLLUTION THREATS

Point Sources

Globs of oil are found several times a year on Pebbly Beach and on sea birds in the ASBS. Vessels cleaning their bilges at sea may be responsible for this. It is also possible that this oil may result from natural seepage from an as yet unlocated source. The last occurrence of oil on the beach was in January 1978 after a large storm; rangers claim that the appearance of oil is usually preceded by storms. The consistency of the oil closely resembles that of natural tar. The fact that this occurs only on one beach also suggests natural seepage, but further investigation would be necessary to establish this as the cause.

Plans for a nuclear power plant at Moss Landing are now under consideration. Most nuclear power plants in existence have occasional incidents in which radioactive substances are discharged into the environment. Many fish, invertebrates and algae are able to concentrate radioactive material (Odum, 1971). Should an incident occur at Moss Landing, there is a possibility that the southern flowing current could contaminate the organisms in the ASBS with radioactive material.

The present Carmel submarine sewer outfall discharges secondary treated effluent to Carmel Bay 600 ft. (180 m) offshore at a 45-ft. (14 m) depth. Because the discharge is within the Carmel Bay ASBS, there are tentative plans to extend the outfall further offshore. Not enough is known of currents at this time to determine if wastes from this outfall, or a longer one, would be carried into the Point Lobos ASBS. With the present system, there has been some carry-over of solids into the effluent; however, new equipment has been designed to eliminate this problem (ESI, 1977). Coliform levels at Bluefish and Whaler's Coves fluctuate, but have remained below the upper "safe" limit for water contact by humans. These should be monitored carefully if changes in the Carmel sewer outfall do occur.

Non-Point Sources

Dumping of garbage and wastewater by tourists and camping trailers occurs directly north and south of the ASBS according to rangers, and much of this could find its way into the ASBS via local currents. Besides detracting from the aesthetic value of Point Lobos, wastewater could introduce harmful particulates and chemicals into the ASBS.

Wood debris from the Carmel River often ends up on the southern shore of the ASBS. While this is not potentially harmful, it indicates that runoff from the Carmel River enters the ASBS. Storm water runoff from the City of Carmel is collected by culverts and drains and approximately 40% is discharged into Carmel River. The remainder is discharged directly into Carmel Bay. Storm water may contain oil, asbestos, metal and rubber residues from automobiles and highways, and pesticides from gardens and farms, which could be harmful to the organisms in the ASBS. The Carmel River may also contain fertilizer runoff and silt from upriver farming and heavy silt from development and from natural sources. Point Lobos rangers reported that, after a small dredging operation to clear the Carmel River after winter storms, excess organic debris (plant material) was observed on the south shore of the ASBS.

Plans for development of a small harbor at Stillwater Cove should be examined carefully with regard to the ASBS. Increased sediments in the water from construction and vessel discharges could affect the ASBS, although not enough is known about local current patterns to be certain of this.

Another potential pollution source is the proposed development of Point Lobos Ranch, which lies directly east of Highway One and which extends from the southern boundary of the ASBS to well past the northern boundary. The proposed development includes an inn with fifty rooms and a restaurant, 40-75 condominium units containing at least 150 rooms, another 200-room facility, tennis court, pool, enlarged horse ranch with bridle trails, 30-50 single family homesites at a maximum density of fourteen homesites per acre and an additional 5-6 homesites in San Jose

Creek Canyon (Whisler-Patri, 1977). Provisions will be made for scenic easement adjacent to Highway One and undesignated open space (Whisler-Patri, 1977). Plans also include a parking lot at Monastery Beach and an improved Point Lobos Reserve entrance.

Water will be supplied by San Jose Creek and possibly within 8-10 years by the California American Water Company. The individual homesites will have septic tanks. An onsite advanced secondary treatment plant is proposed, with effluent sprayed on landscaped areas or permanent pastures. Run-off systems have been designed to "avoid" adverse impacts on down-slope areas of Point Lobos Ecological Reserve, but these systems are not described and should be examined closely by those concerned with water quality in the Reserve.

Most of the high-dentisy development would be within .25-.50 mi. (0.5-0.8 km) of the ASBS. Although these will be out of sight of most of the Reserve, they may be seen in part. Development will be allowed in areas of moderate erosion hazard; this may introduce extra sediments into the ASBS. The enlarged horse ranch and bridle trails should also be examined in more detail to determine if they cross Gibson Creek or San Jose Creek.

SPECIAL WATER QUALITY REQUIREMENTS

The ASBS is unique in the diversity of the subtidal biota. This diversity may, in part, be due to the excellent water clarity found in the region. The extreme depth to which the giant kelp occur, as well as the abundance of sessile filter feeders, is dependent on the amount of sediment (mud, silt) in the water. Large amounts of suspended sediment reduce the clarity of the water and therefore, decrease the depth of the photic zone. Such sediment can also be harmful to many of the sessile filter feeders because it can clog their filtering apparatus and interfere with normal feeding. Therefore, it is important that the sediment load of the waters within the ASBS not be increased over present levels.

ANNOTATED BIBLIOGRAPHY

Barry, W.J., J.D. DeMartini, L.C. Cutshall. 1977. Point Lobos State Reserve and Carmel River State Beach Resource Inventory. Resource Preservation and Interpretation Division, Sacramento, Calif. 118pp.

This report describes the climatic, oceanographic, geological, biological, cultural and recreational aspects of the reserve. A number of maps of the area, prepared by the Department of Parks and Recreation, are included.

Bloom, N., M. Burke and T. Thompson. 1974. Carmel Bay Diving Access Survey No. 1.

This survey was conducted by automobile and on foot to determine possible access points for divers within the ASBS at Gibson Beach, China Cove, Hidden Beach, Pebbly Beach, the second cove south of Sand Hill, Sand Hill Cove, Whaler's Cove and Hudson's Cove (in the newly acquired property). Sea otter nurseries are also noted. 8pp. Available at CDFG.

Bowen, O.E. 1965. Point Lobos, 'Crown Jewel of the State Parks', a geologic guide. Mineral Information Service. A geological description of the marine and terrestrial areas, fossils, geologic history. 8 pp. Available at CDFG.

DeMartini, J.D. and W.J. Barry. 1977. A subtidal resources inventory for Point Lobos State Reserve. Resource Preservation and Interpretation Division, Sacramento, California. This report contains results from qualitative surveys made at ten sites within the reserve and includes information on submarine topography, algae, invertebrates and fish. 51 pp.

Engineering Science, Inc. (ESI). 1977. Oceanographic investigations in Carmel Bay - a review of existing information. Berkeley, Calif., 185 pp.

This report describes the wastewater characteristics of the Carmel Sanitary District Discharge, as well as other point and non-point source discharges into Carmel Bay. The geology (mostly fault activity) and water quality of the bay are described, as is human use. Available at CDFG.

Grinnell, J. 1936. Vertebrate animals of Point Lobos Reserve. 1934-35. Carnegie Institute, Washington. 159 pp.

Primarily concerned with terrestrial vertebrates, but also mentions California and Stellar sea lions.

Johansen, H.W. and L.F. Austin. 1970. Growth rates in the articulated coralline Calliarthron (Rhodophyta). Can. J. Bot. 48:125-132.

This is a study of the biology of C. tuberculosum, a subtidal calcareous red alga. The report describes seasonal differences in growth rate and phenology of the reproductive behavior of female, male and sporangial plants. Study done in Whaler's Cove.

Lobos Reserve State Park. State of California Resources Agency (DPR) (1970). A visitors' guide to the reserve; a non-technical report of marine and terrestrial biota, geology and cultural history. 80 pp. Available at Point Lobos State Reserve.

Nichols, D.R., M. Stone, M. Gordon and R. Decausemaker. 1974. A marine survey of the north shore of Point Lobos State Reserve. Beta Research Oceanographic Laboratories, Inc. 118 pp.

Report describes areas where diving is permitted in the reserve: Coal Chute Cove, Whaler's Cove, North Rocks and Bluefish Cove. Species list of algae, plankton, invertebrates and chordates with abundance noted. Oceanographic description includes data on visibility, oxygen, temperature, coliform count. Marine geology outlined. Report lacks adequate description of exact areas sampled, field methods and equipment used and number of replicate samples taken. Photos, graphs, charts available. Beta Research is a "non-profit corporation composed of scientists and amateur oceanographers" (divers?). Available at Point Lobos.

NOAA. California State Park System. Primary Candidate Station.

Two stations; temperature taken with bucket thermometer daily. Period of record 1968. Available: Surface water temperatures and selected shore stations. SIO Special Publications, F. Wilkes, Scripps Institution of Oceanography, La Jolla, Calif. (714) 452-3668.

Odum, E.P. 1971. Fundamentals of ecology. Saunders, Philadelphia. 574 pp.

Point Lobos Advisory Committee. 1936. Point Lobos Reserve. Save the Redwoods League, Berkeley, Calif. 750 pp.

This is an extensive review of the reserve. Although not up to date, it contains valuable information on the biology, geology, history, archeology, climate and public use of Point Lobos. It describes early state management of the reserve. Available at CDFG.

Ricketts, E.F. and J. Calvin. 1968. Between Pacific Tides. Stanford Univ. Press, Stanford. 614 pp.

State Water Resources Control Board. 1976. Areas of Special Biological Significance. 55 pp.

Thompson, T. 1974. Diving Survey of South Shore of Point Lobos. Memo to Chuck Mehlert. Department of Parks and Recreation.

This report describes the algae, fish and diving conditions at the second cove south of Sand Hill and at Gibson Beach. 3 pp. Available at CDFG.

Whisler-Patri. 1977. A concept plan for Point Lobos Ranch, San Francisco, Calif. 27 pp. Available at Point Lobos Ecological Reserve.

APPENDIX 1

POINT LOBOS ECOLOGICAL RESERVE

DESCRIPTION OF SUBTIDAL SAMPLING SITES

Station 1: Coal Chute Cove. Sampled by Nichols, et al, 1970-1973 and by DeMartini and Barry, 1973, 1975, 1977. Bedrock (conglomerate south, granodiorite north), giant boulders, gravel at mouth.

Station 2: Whaler's Cove. Sampled by Nichols, et al, 1970-1973 and by DeMartini and Barry, 1973, 1975, 1977. Sand with conglomerate platforms forming a series of steps, shallow slope; subtidal caves.

Station 3: Cannery Point. Sampled by Nichols, et al, 1970-1973. High relief, shallow boulders, two deep channels.

Station 4: Bluefish Cove. Sampled by Nichols, et al, 1970-1973 and by DeMartini and Barry, 1973 and 1977. Bottom very smooth, sandy. Eastern perimeter large boulders, canyons, pinnacles.

Station 5: Cypress Cove. Sampled by DeMartini and Barry, 1975. Steep, rocky walls, heavy surge area.

Station 6: North Point. Sampled by Cazanjian, et al, 1978. Big outcrop at 12 m, bottom at 18 m.

Station 7: South Point. Sampled by Cazanjian, et al, 1978. Sand, cobble bottom.

Station 8: Headland Cove. Sampled by DeMartini and Barry 1976. Very

APPENDIX 1 Continued

high relief, extreme water clarity.

Station 9: Sand Hill. Sampled by Cazanjian, _et al_, 1978. Boulders, heavy surge.

Station 10: Sand Hill Cove. Sampled by DeMartini and Barry, 1976, 1977. Vertical walls on perimeter, bottom bedrock and giant boulders, gravel in deeper depressions.

Section 11: Rocks south of Sand Hill Cove. Sampled by Cazanjian, _et al_, 1978. Very high relief, pinnacles, ridges, ledges, deep crevices, bedrock bottom.

Section 12: The Slot. Sampled by Cazanjian, _et al_, 1978. High relief, boulders on deeper flat rock.

Section 13: Hidden Beach: Sampled by DeMartini and Barry, 1977. Shallow to 100 m offshore. Subtidal coarse gravel and bedrock. Seaward bedrock with high relief.

Section 14: Whitecap. Sampled by Cazanjian, _et al_, 1978. Shallow, boulders with wide sandy channels. Deeper flat bedrock with deep canyons and crevices, many ledges on vertical walls.

Section 15: Rocks at the mouth of China Cove. Sampled by Cazanjian, _et al_, 1978. Vertical wall with shallow large shelf, bedrock and sand bottom.

Section 16: China Cove. Sampled by DeMartini and Barry. Shallow, coarse granitic sand with cobble and small boulders. Deeper large boulders.

Section 17: Outer edge of kelp forest north of Bird Island. Sampled by Cazanjian, et al, 1978. Very high relief, large outcrops, vertical cliffs.

Station 18: North side Bird Island. Sampled by Cazanjian, et al, 1978. Vertical wall with many shallow ledges.

APPENDIX 2

POINT LOBOS ECOLOGICAL RESERVE

SUBTIDAL KELP FOREST ASSEMBLAGE

ALGAE

Alaria marginata
Bonnemaisonia nootkana
Bossiella californica ssp. schmittii
Botryoglossum sp.
Calliarthron cheilosporioides
C. tuberculosum
Callophyllus flabellulata
Ceramium sp.
Constantinea simplex
Corallina spp.
Cryptopleura sp.
Cystoseira osmundacea
Derbesia marina
Desmarestia ligulata
Dictyoneurum californicum
Dictyota binghamiae
Eisenia arborea
Erythrophyllum delesseroides
Fauchea laciniata
Fryeela gardneri
Gigartina spp.
Halicystis sp.
Iridaea cordata
Laminaria dentigera
Lessoniopsis littoralis
Lithothamnion sp.
Macrocystis integrifolia
M. pyrifera

APPENDIX 2 Continued

Mesophyllum conchatum
M. lamellatum
Neoptilota spp.
Nereocystis luetkeana
Nitophyllum cincinnatum
Opuntiella californica
Peyssonellia spp.
Phyllospadix scouleri
Plocamium cartilagineum
Polyneura latissima
Postelsia palmaeformis
Prionitis andersonii
P. lanceolata
Pterygophora californica
Rhodymenia pacifica
Weeksia reticulata

PORIFERA (Sponges)
Acarnus erithacus
Cliona celata
Hymenamphiastra cyanocrypta
Leucandra heathi
Leucilla nuttingi
Leucosolenia eleanor
Lissodendoryx noxiosa
Ophlitaspongia pennata
Plocamia karykina
Rhabdodermella nuttingi
Stelletta clarella
Tetilla arb
Tethya aurantia
Toxadocia sp.

APPENDIX 2 Continued

HYDROZOA

Abietinaria spp.

Aglaophenia sp.

Allopora californica

Eudendrium sp.

Phialidium spp.

Plumularia spp.

Stylantheca porphyra

Turbularia spp.

ANTHOZOA (Anemones and Corals)

Anthopleura elegantissima

A. xanthogrammica

Astangia lajollaensis

Balanophyllia elegans

Clavularia sp.

Corynactis californica

Epiactis prolifera

Lophogorgia chilensis

Metridium senile

Paracyathus stearnsi

Tealia crassicornis

Tealia lofotensis

ENTOPROCTA

Barentsia sp.

Pediallia echinata

BRACHIOPODA

Glottidia albida

Lagues californicus

BRYOZOA

Crisia genicularia

Hippodiplosia insculpta

APPENDIX 2 Continued

Lichenopora radiata

Membranipora membranacea

Phidolopora californica

P. pacifica

Retepora pacifica

Thalamoporella sp.

POLYCHAETA (Tube-Dwelling Worms)

Cirratulidae

Dodecaceria concharum

D. fewkesi

Eudistylia polymorpha

Pista elongata

Salmacina tribranchiata

Serpula vermicularis

Spirorbis moerchi

Spirobranchus sp.

CHITONS

Cryptochiton stelleri

Mopalia spp.

Placiphorella velata

Tonicella lineata

BIVALVIA (Clams)

Entodesma saxicola

Hinnites giganteus

Pododesmus cepio

OPISTOBRANCH GASTROPODA (Nudibranchs)

Archidoris montereyensis

A. odhneri

Cadlina luteomarginata

Chromodoris macfarlandi

Dendrodoris fulva

Dialula sandigensis

Dirona albolineata
Doriopsilla albopunctata
Hermissenda crassicornis
Hopkinsia rosacea
Laila cockerellii
Phidiana pugnax
Rostanga pulchra
Triopha carpenteri
T. grandis
T. maculata
Tritonia festiva

CEPHALOPODA (Octopii)

Octopus apollyon
O. bimaculoides

CRUSTACEA

Balanus sp.
Cancer antennarius
C. magister
C. oregonensis
C. productus
Cryptolithoides sitchensis
Heptacarpus sp.
Idothea sp.
Lopholithoides formainatus
Loxorhynchus crispatus
L. grardis
Pagurus spp.
Pugettia spp.
Scyra acutifrons
Spirontacaris sp.
Xanthid crab

ASTEROIDEA (Sea Stars)

<u>Dermasterias imbricata</u>
<u>Henricia leviuscula</u>
<u>Leptastarias hexactis</u>
<u>Mediaster aequalis</u>
<u>Orthasterias koehleri</u>
<u>Patiria miniata</u>
<u>Pisaster brevispinus</u>
<u>P. giganteus</u>
<u>P. ochraceous</u>
<u>Pycnopodia helianthoides</u>

OPHIUROIDEA (Brittle Stars)

<u>Amphiodia occidentalis</u>
<u>Ophioncus granulosus</u>
<u>Ophioplocus esmarki</u>
<u>Ophiothrix spiculata</u>

ECHINOIDEA (Sea Urchins)

<u>Strongylocentrotus franciscanus</u>
<u>S. purpuratus</u>

HOLOTHUROIDEA (Sea Cucumbers)

<u>Cucumaria chronhjelmi</u>
<u>C. curata</u>
<u>c. miniata</u>
<u>Psolus chitonoides</u>
<u>Stichopus californicus</u>

TUNICATA

<u>Archidistoma psammion</u>
<u>Clavelina huntsmani</u>
<u>Cystodytes lobatus</u>
<u>Didemnum carnulentum</u>

APPENDIX 2 Continued

Metandrocarpa taylori
Perophora annectens
Pyura haustor
Ritterella rubra
Styela gibbsii
Trididemnum opacum

APPENDIX 3

POINT LOBOS ECOLOGICAL RESERVE FISH SPECIES

Embiotoca lateralis	(Striped Surfperch)
Hexagrammos decagrammus	(Kelp Greenling)
Jordania zonope	(Longfin Sculpin)
Mola mola	(Common Mola)
Ophiodon elongatus	(Ling Cod)
Orthonopias triacus	(Snubnose Sculpin)
Oxylebius pictus	(Painted Greenling)
Rhacochilus toxotes	(Rubberlip Surfperch)
Scorpaenichthys marmoratus	(Cabezon)
Sebastes atrovirens	(Kelp Rockfish)
S. carnatus	(Gopher Rockfish)
S. caurinus	(Copper Rockfish)
S. chrysomelas	(Black and Yellow Rockfish)
S. mystinus	(Blue Rockfish)
S. pinniger	(Canary Rockfish)
S. serranoides	(Olive Rockfish)

APPENDIX 4

POINT LOBOS ECOLOGICAL RESERVE

SUBTIDAL PEBBLY HABITAT ASSEMBLAGE

ALGAE

Bossiella californica

Calliarthron tuberculosum

Cystoseira osmundacea

Desmarestia ligulata

Dictyoneurum californicum

Fryeella gardneri

Laminaria dentigera

Macrocystis pyrifera

Prionitis lanceolata

Pterygophora californica

Encrusting corallines

PORIFERA (Sponges)

Cliona celata

Leucandra heathi

Hymenamphiastra cyanocrypta

Ophlitaspongia pennata

HYDROZOA

Abietinaria sp.

ANTHOZOA (Anemones and Coral)

Balanophyllia elegans

Clavularia sp.

Corynactis californica

Tealia coriacea

T. crassicornis

T. lofotensis

POLYCHAETA (Tube-Dwelling Worms)

Eudistylia polymorpha

Spirorbis moerchi

APPENDIX 4 Continued

SIPHUNCULIDA (Peanut Worms)

Phascolosoma agassizii

CHITONS

Cryptochiton stelleri

Tonicella lineata

PROSOBRANCH GASTROPODA (Snails and Limpets)

Acmaea mitra

Diodora aspera

Haliotis rufescens

Tegula montereyi

OPISTOBRANCH GASTROPODA (Nudibranchs)

Cadlina luteomarginata

CRUSTACEA

Pagurus sp.

Pugettia sp.

Spirontocaris sp.

ASTEROIDEA (Sea Stars)

Patiria miniata

Pisaster giganteus

Pycnopodia helianthoides

OPHIUROIDEA (Brittle Stars)

Ophiothrix spiculata

TUNICATA

Cystodytes lobatus

Didemnum carnulentum

Metandrocarpa taylori

Tridemnum opacum

APPENDIX 5

POINT LOBOS ECOLOGICAL RESERVE

SUBTIDAL SANDY HABITAT ASSEMBLAGE

ALGAE

Gracilaria sjoestedtii

Gymnogongrus leptophyllus

G. linearis

Neoagardhiella baileyi

Prionitis andersonii

PORIFERA (Sponges)

Polymastia pachymastia

HYDROZOA

Hydractinia sp.

BRACHIOPODA

Glottidia albida

POLYCHAETA (Tube-Dwelling Worms)

Diopatra ornata

Mesochaetopterus taylori

Phragmatopoma californica

Spiochaetopterus costarum

SIPUNCULIDA (Peanut Worms)

Sipunculus nudus

BIVALVIA (Clams)

Clinocardium nuttallii

PROSOBRANCH GASTROPODA (Snails)

Conus californicus

Nassarius mendicus

Olivella biplicata

Polinices draconis

P. lewisii

APPENDIX 5 Continued

CRUSTACEA

Cancer magister

C. productus

Crangon spp.

Pseudosquilla lessonii

Squilla polita

ASTEROIDEA (Sea Stars)

Patiria miniata

Piasaster brevispinus

Solaster dawsoni

OPHIOROIDEA (Brittle Stars)

Ophioplocus esmarki

ECHINOIDEA (Sand Dollars)

Dendraster excentricus

HOLOTHUROIDEA (Sea Cucumbers)

Caudina chilensis

Stichopus californicus

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